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Philosophical Principles

OF

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NATURAL

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In Two PARTS.

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LONDON:

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Philoſophical Principles
OF
RELIGION:
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In Two PARTS.

Part I. Containing the *Elements* of *Natural Philoſophy* and the Proofs of NATURAL RELIGION ariſing from them. The Second Edition Corrected and Enlarged.

Part II. Containing the *Nature* and *Kinds* of INFINITES; their ARITHMETICK and USES: together with the *Philoſophick Principles* of REVEAL'D RELIGION. Now firſt Publiſh'd.

By GEORGE CHEYNE, M. D. and F. R. S.

LONDON:
Printed for GEORGE STRAHAN at the *Golden-Ball* in *Cornhil*, over againſt the *Royal-Exchange*. MDCCXV.

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To His GRACE

JOHN,

DUKE of *ROXBURGH*,

Marqueſs of *Bowmont* and *Ceſsford*, Earle of *Kelſo*, Viſcount of *Broxmouth*, Baron *Ker* of *Ceſsford*, and *Cavertoun*, &c.

Keeper of His MAJESTIES Great Seal, in *Scotland.*

May it pleaſe your GRACE,

AS *you condeſcended to do me the Honour to ſuffer your* Name *to be prefix'd to the former Edition of this Work:* So *I humbly Hope,* Your Grace *will continue the ſame Goodneſs, to this more full and correct One. I ſo deeply and juſtly Honour* Your Grace, *that, as I am ſure you do not expect, ſo I own I dare not beſtow, the Compliments uſual in Addreſſes of this Kind. That* Your Grace *may Live an*

Example *of* Solid Virtue, *in your High Rank here, and may be* Crowned with an exceeding Weight of Glory *hereafter, is the Earneſt* Prayer, *of*

May it pleaſe your Grace,

Your Grace's

moſt oblig'd

moſt Faithful,

moſt humble Servant,

Geo. Cheyne.

PHILOSOPHICAL PRINCIPLES OF Natural Religion.

PART I.

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THE PREFACE

To the firſt Part.

I Had not given the World any further Trouble with my poor Labours on ſuch uncertain and *intricate* Subjects as are here treated of, had I not been often Sollicited to give orders for another *Edition* of this Work, for the Uſe of the Younger Students of *Philoſophy*, who while they were taught the moſt probable account of the *Appearances of Nature* from the Modern Diſcoveries, might thereby have the *Principles* of *Natural Religion* inſenſibly inſtill'd into them at the ſame time. This, with the Conſent and Approbation of thoſe, whoſe Advice will be always ſacred with me, were the Principal Motives to this *Edition*; and while it was under Hands, I was inclined to have it as correct and full, as the Animadverſions and Corrections of thoſe *Friends*, who were capable and willing to undertake them; my own low Abilities, uncertain Health, and neceſſary Avocations wou'd permit.

I had ſeen the Obſervations and Corrections, the *late Ingenious and Learned* Dr. *Gregory*, *Savilian Profeſſor of Aſtronomy*, at *Oxford*, had made on the former *Edition* of this part I had ſome Remarks from the *Reverend and Learned* Mr. *John Craig*; as alſo ſome very Judicious Reflections from a *Gentleman at Cambridge* who conceals his Name. Theſe I freely uſed, with the beſt Judgment and utmoſt Application I was capable of, to make the Corrections and Emendations of this Part now again Publiſhed. As to the Additions, beſides what my own Reflections ſuggeſted, the principal ones were taken from the Second Editions of Sir *Iſaac Newton's* (*that great Inventor and Improver of moſt of our Modern Philoſophy and Geometry*) his *Opticks* and *Mathematical Prin-*

ciples of *Philoſophy*; Mr. *Cotes*, (*the Learned Plumian Profeſſor of Aſtronomy at Cambridge*) his Preface to that Edition; the *Reverend and Learned* Mr. *Derham's two late Pieces*; *the Philoſophical Tranſactions*, and *the Memoirs of the Academy Royal at* Paris. I Intended to have had theſe Alterations and Additions printed by themſelves, for the Benefit of thoſe who had the firſt Edition, but I found it was impracticable.

I am very Senſible, the beſt accounts of the Appearances of Nature (in any ſingle Inſtance how minute or ſimple ſoever) Humane Penetration can reach, comes infinitely ſhort of its reality, and internal Conſtitution; for *who can ſearch out the Almighty, or his works to Perfection.* Some of the groſſer Out-lines and prominent Lineaments of Nature, are as near, as is allowed to Mortals to approach. But this I think I may venture to ſay, that *Atheiſm*, may be Eternally confounded, by the moſt diſtant Approaches to the true cauſes of

Natural Appearances. And that if the *Modern Philoſophy* demonſtrates nothing elſe, yet it infallibly proves *Atheiſm* to be the moſt groſs Ignorance.

THE

CONTENTS.

CHAP. I.

Of the Phyſical Laws *of* Nature.

Article I. *The* Introduction, Pag. 1

§ 2. *An Explication of the Senſe wherein* Nature, *and its* Laws *are here taken,* p. 2

§. 3. *The Opinions of ſome* Philoſophers, *about* Nature *and its* Laws, *conſider'd, and the Miniſtry of* Subordinate Spirits *confirm'd,* p. 3 & ſeq.

§. 4. *The* Scheme *of* Nature *according to the Modern* Philoſophy, p. 5

Of the Phyſical Laws *of* Nature, p. 7 & ſeq.

§. 5. *The* firſt Law *of* Nature, p. 7

§. 6. *A* Demonſtration *of the* firſt Law *of* Nature, p. 7

§. 7. *An* Explication *and* Demonſtration *of the* Vis inertiæ, *in Bodies,* p. 8 & ſeq.

§. 8. *That* Bodies *can neither* move, *nor alter the* Direction *of their Motion of* themſelves, p. 10

§. 9. *That*

§. 9. *That a* Body *cannot move in a* Curve Line *of it* ſelf, ibid.

§. 10. *That the* Celeſtial Bodies, *do not move of* themſelves, *in their* Orbits, p. 11

§. 11. *That neither* Motion *nor* Reſt, i. e. *that neither of theſe particularly, is eſſential to* Matter, ibid.

§. 12. *The Neceſſity of a* Vacuum *demonſtrated,* à priori & poſteriori, p. 12 & ſeq.

§. 13. *The* ſecond Law *of* Nature, *with its* Demonſtration. p. 15

§. 15. *The Impoſſibility of a* perpetual Motion, *demonſtrated, on the* modern Scheme *of* Nature. p. 16 & ſeq.

§. 15. *The* third Law *of* Nature *with its Demonſtration.* p. 18

§. 16. *The Method of* compounding *and* reſolving Motions, *demonſtrated,* p. 20

§. 17. *The* Proportion *of an* oblique *to a* perpendilar *Impulſe, demonſtrated,* p. 21

Ibid. *The* Proportions *of* three *Forces drawing in* three *different* Directions, *in* Æquilibrio. p. 23

Ibid. *A* Rule *to diſtinguiſh* Mechaniſm *from what is not ſo, according to the* modern Philoſophy p. 24

CHAP. II.

Of Attraction or Gravitation in Bodies, and an account of ſome of the Appearances of Nature, from this Principle, and theſe Laws now eſtabliſh'd.

§. 18 T*HE poſſible Ways, the* Celeſtial Bodies *can be retain'd in their* Orbits, 25
§. 19. Des Cartes, *his* Hypotheſis *about the Formation of the Univerſe, and the Cauſes of the* Celeſtial Motions, p. 26 & ſeq.
§. 20. *This* Hypotheſis *is confuted at large,* p. 28 & ſeq.
§. 21. *Mr.* Leibnitz's *Opinion about the* Cauſes *of the* Celeſtial Motions, p. 31 & ſeq.
§. 22. *This* Hypotheſis *not ſufficient, nor ſatiſfactory,* p. 33 & ſeq.
§. 23. *The Opinion of ſome other* Philoſophers *about the Cauſes of* Gravity, *conſidered and rejected,* p. 35 & ſeq.
§. 24. *That the* Principle *of* Attraction *is the moſt probable Cauſe of the Celeſtial Motions,* p. 39 & ſeq.
Ibid. *That the* Gravitation *of Bodies, is not a* Principle *eſſential to Matter,* p. 40
Ibid. *That this* Principle *of* Gravitation *is probably, a divine* Virtue *or* Energy *impreſs'd on Matter,* p. 41
Ibid. *The Difficulties againſt this Opinion clear'd,* p. 42 & ſeq.

CONTENTS.

Ibid. *A* Principle *analogous to this of* Gravitation *in Bodies ſhewn in* ſpiritual ſubſtances, *to wit, that of* Re-union *with their* Origin, p. 46. & ſeq.

Ibid. *The* Analogy *between theſe two Principles in their different Subjects, illuſtrated in ſeveral* Inſtances, p. 46 & ſeq.

§. 25. *The* Motions *of the* Celeſtial Bodies *and their Perpetuity, ſhown from this* Principle *of* Gravitation, p. 51 & ſeq.

Ibid *The Difficulty, of conceiving how by this Law, a Body can approach to, and recede from the* attractive central Body *explain'd,* p. 53

Ibid *An Explication of the* Flux *and* Re-flux *of the* Sea *from this* Principle, p. 55

Ibid. *That the* Gravitation *by which the* Moon *turns round the* Earth, *is of the ſame Nature, with that by which* heavy Bodies *tend to the* Center *of the* Earth, p. 57

§. 26. *The* Nature *and* Cauſe *of* Fluidity *explain'd, and the* Conditions *neceſſary to conſtitute the* denſer Fluids, p. 59

§. 27. *The* Figure *of the Parts, and the probable* Nature *and* Appearances *of the* Element *of Water.* p. 60

§. 28. *The* Nature *of Cold, and the manner of freezing explain'd,* p. 61

Ibid. *That the* Quantity *of Water on the* Earth, *continually decreaſes,*

§. *The* Figure *of the Particles, the Properties and* Nature *of* Mercury *explain'd,* p. 65

§. 30. *The* Natures *and* Properties *of* Air *explain'd*, ibid.
§. 31. *How from ſo few* Primitive *Fluids, as* Air, Water, Mercury *and* Light, *the infinite variety of compounded Fluids may be accounted for*, p. 66 & ſeq.
The Nature *and Properties of Light*. p. 68 & ſeq.
§. 32. *That* Light *is a Body, or material Subſtance*, p. 68.
§. 33. *How extreamly ſmall, the parts of* Light *are.* p. 69
§. 34. *With what an extream Velocity, the Fluid of* Light *is projected from the* Sun *and* fixt Stars, p. 71
§. 35. *The Nature of the* Sun *and* fixt Stars, p. 72
Ibid. *The manner after which the Fluid of* Light *is projected, from the Body of the* Sun *and* fixt Stars, p. 73
§. 36. *That Bodies and* Light *act mutually upon one another.* p. 74
Ibid. *The* Laws *of* Reflexion, *and* Re-fraction *of* Light *explain'd from Bodies attracting the Rays of* Light, *in a certain manner.* p. 75
§. 37. *That* Light *conſiſts of Rays defferently* refrangible *and* reflexible, p. 78
Ibid. *What the* primitive *and* original *Colours are*, p. 79
Ibid. *What* Colours *are made by the leaſt* refrangible *Rays, and what by the moſt*, ibid.
Ibid. *What* Colours *are in* themſelves, *in the* Objects, *and in our Senſations*, ibid.

CONTENTS.

§. 38. *The Cauſe of the* Reflections *and* Refractions *of Light*, p 80

§. 39. *That all* Bodies *have their* refractive *Powers, proportional to their* Denſities, p. 82

§. 40. *The* natural Cauſe, *why Bodies exhibit different* Colours, p. 83

Ibid. *A ſhort* Summary, *of the Nature and Properties of* Light *and* Colours, p 83 & ſeq.

Ibid. *That the Quantity of* Light *and* Heat, *in the* Sun, *and* Fixt Stars, *is conſtantly diminiſhing*, p. 88

Ibid. *The* Cauſe *of the Emiſſion of Gleams of* Light, *by glaſs* Recipients, *evacuated of* Air, *and violently agitated*, p 90

Ibid. *The probable* Cauſe, *of appearing and diſappearing* Fixt Stars, p. 91

§. 41. *That ſeveral different* Laws *of* Gravitation *may be found neceſſary, to account for different Appearances*, p 92

§. 42. *The* Appearances *of* Coheſion *and* Solidity, *and the plainneſs of the Cohering Surfaces, ſhown to be one Condition of the Cauſe thereof*, p. 93

§. 43. *An Inquiry into the Condition, of the general* Principle *of* Gravitation, *that ſeems beſt to account for the* Appearances *of* Coheſion, p 96 & ſeq.

Ibid. *The Difficulties in accounting for the* Coheſion *of Bodies, from any Law of* Gravitation, p. 106

§. 44. *An Endeavour to explain* Elaſticity, *from the Principle of* Attraction, p. 107

Ibid.

Ibid. *The Difficulty explain'd, how a* Spring *ſhou'd grow ſtronger, the more it is bent,*
Ibid. *That* Elaſticity *may be better explain'd, by an* Elaſtick *Fluid,* p. 110

CHAP. III.

Of the *Origin*, and of the preſent State of things, and of the *Epicurean* and *Mechanical Hypotheſis.*

§ 1. THE *Introduction.* p. 111
§ 2. *The* Epicurean Hypotheſis *explain'd,* p. 112
§ 3. *That matter has no other Quality ſuitable to* Self-Exiſtence, *with which this* Hypotheſis, *ſuppoſes Matter endow'd,* p. 112
§ 4. *This* Syſtem *of things, cou'd not have been* Mechanically *produc'd, becauſe* Motion *is not* eſſential *to Matter,* p. 113
Ibid. *Two different* Demonſtrations, *ſhewing Motion not* eſſential *to* Matter, p. 114
§ 5. Obliquity *of* Direction, *inconſiſtent with the* Nature *of* Matter, p. 115
§ 6. *Suppoſing* Motion eſſential *to* Matter, *yet it's parts (congruous to it's* Nature) *cou'd only have moved in Lines* parallel *to one another, and ſo cou'd have produced nothing,* p. 117
Ibid. *That to aſcribe to* Matter, *a Power to change*

it's Direction, *is to make it a* free-will'd Agent, ibid.

Ibid. *Allowing Matter a* Self-Motion, *and an* oblique Direction, *yet nothing but* fluid *or* ſolid Spheres, *cou'd have been produced*, p. 118

§ 7. *Allowing Matter a* Self-Exiſtence, Self-Motion, *and an* oblique Direction, *yet it cou'd not have produced this* Syſtem *of things*, Ibid.

§ 7. *That* Solidity *or* Coheſion, *cou'd never have ariſen from one or all of theſe Properties*, p. 119

§ 8. *There are ſeveral Appearances in Nature, inconſiſtent with, and unaccountable from meer* Mechaniſm, p. 121

§ 9. *All the* Celeſtial *and* Terreſtrial *Appearances, that have been explain'd from the Principle of* Attraction, *are unaccountable from meer* Mechaniſm, p. 121

Ibid. *An obvious* Demonſtration, *from the* Celeſtial *Appearances, that the Motions of theſe Bodies, cou'd not proceed from meer* Mechaniſm, p. 123

§ 10. *The Production of* Animals *above the Power of* Mechaniſm, p. 124

Ibid. Animals *demonſtrated, to be* perpetua Mobilia, *and therefore above the Power of* Mechaniſm, p. 125

Ibid. *That the different* Organs *in* Animals *are* relatively infinite, *and therefore above the Power of* Mechaniſm, p. 126

Ibid. *That in the Production of* Animals, *there was a Neceſſity, that all the parts (liquid and ſolid)*

ſolid) ſhou'd have been form'd at the ſame inſtant, and therefore the Production of Animals, *is above the Power of* Mechaniſm, p. 129
§ 11. *The* ſpontaneous Motions, *of the* Senſitive *Tribes, above the Power of* Mechaniſm, p. 132
Ibid. *A Demonſtration of ſomething above the Power of Mechaniſm in Brutes,* p. 133
§ 12. *The* voluntary *Motions of* Rational *Creatures, above the Power of* Mechaniſm, ibid.
Ibid. *How the* voluntary *and* involuntary Functions *of* Animals, *may be perform'd,* p. 134
§ 13. Freedom *and* Liberty, *inconſiſtent with Mechaniſm,* p. 138
Ibid. *Several* Demonſtrations, *of the* Freedom *and* Liberty, *of* Rational *Creatures,* p. 139
Ibid. *The true* Definition *and* Nature *of* Liberty, p. 141

CHAP. IV.

Of the eternal Production and Duration of the preſent ſtate of things.

§ 1. THE Ariſtotelian Hypotheſis, *of the Origination of the Univerſe.* p. 142
§ 2. *That the* Univerſe *cou'd not have been from all* Eternity *of it ſelf, becauſe it requires an* extrinſic Principle, *for it's preſent Subſiſtence,* p. 144

§ 3. *That all things in this* Univerſe, *have an* end, uſe *or* Deſign, *which imply* Contrivance *and* Creation, *and not* Self-Exiſtence, ibid.

Ibid. *That nothing is* ſupernumerary *or* uſeleſs, *but was for ſome wiſe Purpoſes, which imports* Deſign, *and conſequently* Creation, *and not* Self-Exiſtence, p. 147

§ 4. *That* Animals *cou'd not have been from all* Eternity, *for the Reaſons alledged in the two former* Sections, ibid.

Ibid. *Some Reaſons to ſhow, that this preſent ſtate of things naturally tends to* Decay, *and* Diſſolution p. 149

§ 5. *That the* Quantity, *of* Fluids *in all the* Planets, *has been conſtantly decreaſing, and conſequently had the World been from all* Eternity, *there had been no* Fluids *extant in our* Syſtem *at preſent, even ſuppoſing the conſtant ſupply from the* Comets, ibid.

§ 6. *That ſince the* Heat, Light *and* Bulk, *of the* Sun, *and* fixt-Stars, *conſtantly decreaſe, had the World been from all* Eternity, *they had been all extinguiſhed e'er now.* p. 151

Ibid. *The* waſte *of the* Sun's *Heat and Light, by the approach of* Comets; *and their uſe, for rekindling extinct* fixt-Stars, p. 152

§ 7. *That the* Celeſtial Bodies, *do not move in altogether* void, *or* empty Spaces, *but ſuch as make ſome very ſmall Reſiſtances to their Motions, which had the World laſted from all* Eternity, *had quite deſtroyed the Motions of thoſe* Bodies, p. 153

§ 8. *The real, tho' inſenſible changes happening to the* Celeſtial Bodies, *by their* Actions *upon one another, muſt at laſt quite change the preſent face of things,* p. 156

Ibid. *That the* Nature *of material Bodies is to change and alter their* Figure, Bulks, *and* Motions, p. 160

Ibid. *That there are many* ſuſpicions *of great changes having happen'd to the* material *World, which is unaccountable from any other Philoſophy, but that of* Chriſtianity, p. 162

§ 10. *Since the* Material World *is finite in its Extent, the* Celeſtial Bodies *had been all amaſſed in the Center of the Material World, by their* Attraction *upon one another, had the World been from all* Eternity, p. 163

Ibid. *A* Demonſtration *of the Limited Nature, and* Finitude *of the* Material *World,* p. 165

§ 11. *Had the* World *been from all* Eternity, *the firſt of every* Species, *of* Animals, *muſt have been infinitely big,*

§ 12. *Had the* World *laſted from all* Eternity, Arts *and* Sciences, *and particularly* Mathematicks, *had arrived to a greater degree of perfection than they have attain'd,* p. 170

§ 13. *Had the* Number *of any generated thing on this* Globe, *either conſtantly increaſed or decreaſed in any finite number of Years how great ſoever, by any finite number how ſmall ſoever, then this World cou'd not have been from all* Eternity, p. 173

§ 14. *That this* World *muſt have been Created by*

the Supreme Being, *when it was his Pleaſure,* p. 175
Ibid. *The Nature of* Self-Exiſtence, *and what it implies in its poſitive* Idea,

CHAP. V.

Of the Exiſtence of a Deity.

§ 1. THE *Introduction,* p. 178
§ 2. *That all the Arguments of the preceeding* Chapter, *are ſo many* Demonſtrations *of the* Exiſtence *of ſome* Supreme Power, p. 180
§ 3. *That the* Exiſtence *of* Matter, *is a plain proof of the* Being *of a* God, p. 182
§ 4. *That the preſent ſtate of Things, muſt of Neceſſity have been formed by different* Laws *and* Principles, *from what they are now govern'd by, and therefore muſt have been produced by an* Intelligent Being, p. 184
§ 5. *That not only the firſt* Formation *and* Arrangement *of the* Great Bodies *of the* Univerſe; *But alſo their firſt* Impulſes *along the* Tangent *of their* Orbits, *did require the power of an* Almighty Being, p. 186
§ 26. *That not only the* Formation, *and firſt* Impulſes *in right Lines, of the great* Bodies *of the* Univerſe *did require the power of* Omnipotence, *but alſo their* Centripetal Energy, *did, and does*

does conſtantly require a power above Matter, that is a Divine Influx, p. 187

§ 7. *That the* Exiſtence *of Animals, neceſſarily infers the* Exiſtence *of a* Deity, p. 188

§ 8. *That the* Spontaneous *Motions of* Irrational, *and the* Voluntary *Motions of* Rational, *Creatures, their* Freedom *and* Liberty, *and all the Appearances of Nature, above the powers of* Mechaniſm, *are ſo many proofs of the* Being *of a* God, p. 189

§ 9. *The preſervation of the Being, and the Faculties of Things, neceſſarily requires the Power, and conſequently the* Exiſtence *of a* Deity, p. 190

Ibid. *The true Nature and Origin of the* Being, Preſervation, *and* Immortality *of Creatures,* p. 191

§ 10. *The argument for the Exiſtence of a* Deity, *from the* Wiſdom *and* Meliority *of the Creation, is that which has the nobleſt effect on the Minds of moſt Men,* p. 194

§ 11. *A* General View *of the works of* Creation, *and a repreſentation of the whole* Syſtem *of Things, ſhewing how the* Cæleſtial Bodies *are ranged through the* Univerſal Space, p. 195

§ 12. *The* Numbers *that repreſent the* Periods, Diameters, Diſtances, Gravities, Bulks, *and* Quantities *of Matter, in thoſe of the* Cæleſtial Bodies, *which have afforded means for determining the ſame, from the lateſt Obſervations.* p. 197

§ 13. *A Reflection on the* Beauty, Order, Simplicity,

plicity *and* Concinnity, *of this neat and compact* Syſtem *of Things*, p. 201

§ 14. *The* Nature *of the* Sun, *the Range, Order and* Viciſſitudes *of Seaſons, the* Diſtances *and* Motions *of the* Celeſtial Bodies, *in our* Planetary Syſtem, p. 203

§ 15. *The* Analogy, *and Reſemblance of the* Planets *to our* Earth, *and of their* Satellits *to our* Moon, *demonſtrated, with their* Uſes, *the* end *of their Creation, their* Periods *and* Motions, p. 208

§ 16. *The* Motions, *and* Irregularities *of the* Moon, *ariſing from the* Actions *of the* Sun *and* Earth, p. 211

§ 17. *Of the* Nature, Diſtance *and* Light *of the* fixt-Stars, p. 213

Ibid. *Mr.* Derham's *Conjecture about the appearing and diſappearing* fixt-Stars, *conſider'd*, p. 216

§ 18. *The nature of* Comets, *the Laws of their Motions, the Cauſe and Magnitude of their* Atmoſphere *and* Tails, *with their* ends and uſes, *in ſome inſtances of latter Comets illuſtrated*, p. 217 & ſeq.

§ 19. *A* Demonſtration *of the* Beauty, Wiſdom *and* Meliority, *of this our* Planetary Syſtem, p. 221

Ibid. *From the conſtant* Proportion, *between the Times of the* Periodical Revolutions *of all the* Celeſtial Bodies, *and their* middle Diſtances, ibid.

Ibid.

Ibid. *From the ſame Principle, viz. that of* Gravitation, *and one Condition thereof, producing the conſtant Motions of all the* Celeſtial Bodies, p. 122
Ibid. *From the conſtant* Proportion, *between the Times and the* Area's *deſcrib'd, by a Ray from the* Sun, ibid.
Ibid. *From the Diſtances of the* Planets, *from the* Sun, *in reſpect of their* Denſities, p. 224
Ibid. *From the pitching upon that* Proportion, *which ſuits the whole* Syſtem *beſt, in an Infinity of others, over or under, which wou'd not have fitted the whole* Syſtem *ſo well.*
Ibid. *From their being in a conſtant regular* Proportion, *in a ſettled* uniform *Order, when they might have been* irregular, *uncertain, and inconſtant in all their Affections.* p. 229
§ 20. *Some more particular Reflections, upon the* Meliority *of the Frame and Conſtitution of the* Celeſtial Bodies, p. 231
Ibid, *The incredible Number, immenſe Diſtance, the beautiful Diverſity, of the Magnitude of the* fixt-Stars, p. 232
§ 21. *The* uſe *and neceſſity of the* Sun *to* Animals *and* Vegetables, *the miſerable ſtate of thoſe who are depriv'd of his Influence,* his *Motion about his own* Axe, *the Cauſe and Neceſſity thereof,* ibid.

Ibid. *A* Demonſtration *of the Motion of the* Earth, *and the ſtability of the* Sun, *the neceſſity and reaſon thereof,* p 235

§ 22. *The* Uſe *and neceſſity of the* Moon, *the dreadful conſequences of her not having been, to the* Animals *and* Vegetables *of our* Earth, *the* Uſeleſſneſs *of more* Moons, p. 236

Ibid. *The great Benefits ariſe to our* Globe, *from the* Tides *which are produc'd by the* Moon, p. 238

Ibid. *The* Wiſdom, Contrivance, *and* Uſe *of the* Satellites *of* Jupiter, *to their* Primary Planet, p. 240

Ibid. *The* Wiſdom, Contrivance, *and* Uſe *of the* Satellites *of* Saturn, *to their* Primary Planet, p. 241

§ 23. *Some farther Obſervations upon the* Nature, Motions, *and* Uſes *of the* Comets, p. 244

§ 24. *The* Wiſdom *of the* Contrivance *of our* Globe, *the* Earth, *the neceſſity and Uſe of its* Revolution *about its own* Axe, *whence the* Alternation *of* Day *and* Night *proceeds, the fatal inconveniencies of a perpetual* Day, *or* Night, *or of one half of the Years being* Day, *the other* Night, p. 296 & ſeq.

§ 25. *The* Wiſdom *of the* Combination *of the* Diurnal Rotation, *with the* Annual Revolution *of the* Earth *about the* Sun, *the Uſe and Neceſſity of the* Seaſons *of the Year, the Diſad-*

vantages

vantages of any one perpetual Seaſon, *or of fewer than we enjoy,* p. 254

Ibid. *The* Nature *of* Vegetation, *and the Cauſes of* Fertility, p. 257

§ 26. *The great Advantages of the preſent* Obliquity *of the* Equator *to the* Ecliptick, *the inconvenience of their* Coincidence *in the want of the* Seaſons *of the Year, and of the greater Degree of Heat in thoſe places which want it moſt,* p. 260

§ 27. *The wonderful* Wiſdom *of the nice* Adjuſtment *of the diſtance of the* Earth, *and the reſt of the* Planets *from the* Sun p. 263

Ibid. *The Advantages of the* Orbicular *Figure of the* Earth. p 264

§ 28. *The Nature, Extent, and many advantages of our* Atmoſphere, *its neceſſity for Life and Vegetation, for the ſupport of our Clouds and Vapours for Rain, and freſh Water, for Sailing our Ships, and drying our Marſhes,* p. 267

§ 29. *The Deſign, and Advantages of our* Mountains, *that they are the indiſpenſable condition, of our* Freſh Water *and* Rivers, *and give them thoſe beautiful Turnings and Windings which makes them enrich ſo many Countries in their Courſe,* p. 272

Ibid. *The nature and manner of raiſing Clouds and Vapours from the* Sea, Lakes, *and* Marſhy Grounds, p. 274

Ibid. *That Mountains are the* Neſts *or* Matrices *of our* Metals *and Minerals,* p. 278

§ 30. *The vaſt Uſe, Neceſſity, and Beauty, of our*

Fluids,

Fluids, *the fewneſs of the* Primitive *Fluids, the great diverſity and advantages of their* Specifick Gravities, *with the univerſal condition of their* Preſſure *on the ſides of the containing Veſſels* p. 280

Ibid. *The cauſe and neceſſity of the* Law *of their* Preſſure, *and a* Demonſtration à priori *of the Figure of their conſtituent Particles,* p. 282

§ 31. *The wonderful* Beauty, Subtilty, *and* Simplicity *of the Fluid of* Light, *and the noble* Idea *Sir* Iſaac Newton's *latter diſcoveries of its Nature preſents us with,* p. 284

§ 32. *Some reflections on the Nature of the Internal parts of the* Earth, *of* Vulcano's *and* Fiery Eruptions, *of a* Central Fire, *and of the* Annulus *of* Saturn, p. 228

CHAP. VI.

The Proofs for the Being of a GOD ariſing from the Contemplation of the Humane Structure.

§ 33. OF *the* Animal Oeconomy, *and of the inſufficiency of the* Hypotheſis, *of the* Philoſophers *to account for the* Animal *appearances,* p. 294

A General view of the Animal Oeconomy, p. 295 & ſeq.

§ 34. *The manner and cauſe of* Digeſtion, *and the courſe of the* Aliment *till it is mix'd with the Blood,* Ibid.

§ 35 *The* Structure *of the* Glands, *the* Nature, Laws, *and manner of* Secretions *in general, the general conditions, neceſſary for* Secretions, *and an account of ſome of the particular* Ones, p. 298

§ 36. *The* Structure *and* Uſe *of the* Lungs *according to the Modern Diſcoveries, with a conjecture of another uſe of them, not hitherto obſerved, to wit, for forming the* Blood Globules, p. 307

§ 37. *The* Structure *of the* Muſcles, *as commonly received, with the Conjectures of* Philoſophers, *about* Muſcular Motion, *and of the Nature of the Nerves,* p. 313

§ 38. *The moſt probable* Cauſe *of all the Motions of the Fluids, in an* Animal Body, *the Structure and ſeveral Coats of the Veſſels,* p. 314

§ 39. *The* Nature *and* Manner *of* Senſation *in General, and the true Manner of* Generation *and Production of all Animals and Vegetables, with the nature and manner of* Nutrition, p. 318

§ 40. *Some general Reflections upon the* Wiſdom, *and Contrivance of the* Animal Structure p. 323

§ 41. *The wonderful contrivance of the* Skin *and* Scarfe-Skin, *with the manner and* Organs *of Feeling, and the admirably wiſe adjuſtment of this Senſe to the Bodies about us,* p. 325

§ 42. *Some ſurprizing Inſtances of* Wiſdom, *in*
the

the order and diſpoſition of the Muſcles, *and the proportionating the Expences of* Animal Spirits *to the labours we are obliged to undergo,* p. 329

§ 43. *Inſtances of great* Wiſdom *and* Meliority *in the Structure of the* Articulations *and ſtrength of the Bones; The noble and amazing Fabrick of the* Back-bone, *and the wonderful contrivance to obtain a greater ſtrength to the Bones, in proportion to their weight,* p. 334

§ 44. *The admirable ſtructure of the* Brain *and* Nerves, *the noble Fabrick of the* Heart, *the different Texture of this* Organ *in Animals not born, from what it becomes in thoſe when Born: the great and wiſe* End, *and neceſſity of this Diverſity,* p. 340

§ 45. *The noble and divine* Geometry *in the Fabrick of the* Eye, *the neceſſity and advantages, the nature and manner of* Viſion, *with the wiſe adjuſtment for every Animals diſcerning objects, in proportion to their own Bulks and Sizes. The inconveniences of a different Structure, with ſome reflections on the Eyes of particular* Animals, p. 344

§ 46. *The wonderful contrivance of the* Ears, *the great uſe and neceſſity, with the manner and* Mechaniſm *of* Hearing: *the nice adjuſtment of this Senſe, to the motions of Bodies about us,* p. 354

§ 47. *The contrivance and uſe of the* Valvs *in the* Arteries

Arteries *and* Veins, *the great benefit of the* Anaſtomatoſis *of the Veſſels, the wiſe contrivance in the Structure and Poſition of the* Fœtus *in the Womb,* p. 357

§ 48. *Some reflections on the Fabrick and wiſe contrivance of the* Organs *of ſome irrational Creatures, with the concluſion of this Chapter and firſt Part,* p. 358

Philoſophical

Philoſophical Principles
OF
RELIGION.

PART I.

CHAP. I.

Of the Phyſical LAWS *of* NATURE.

§ I. THERE is nothing a more common Subject of Diſcourſe than *Nature* and its *Laws*; and yet, however Uſe has made theſe Words familiar, there are few that agree in their Notions about them: The Reaſon of which ſeems to be, that theſe Terms imply *Notions* ſo compounded, and ſo far remov'd from the Knowledge of moſt Men, that there are ſcarce any that diſtinctly conceive all the Simple *Ideas* that enter their Compoſition; I ſhall not pretend to ſettle the Signification of theſe Words in their utmoſt extent (That being perhaps above the power of Human Faculties in this *Lapſed* eſtate) it will be enough to my preſent purpoſe, to give the Senſe I ſhall apply to them in the following Diſcourſe.

§ II. By *Nature*, I underſtand this vaſt, if not infinite *Machin* of the *Univerſe*, the Perfect and Wiſe Production of Almighty God, conſiſting of an infinite Number of leſſer *Machins*, every one of which is adjuſted by Weight and Meaſure. By the *Laws* of *Nature*, I mean, thoſe Laws of Motion, by which natural Bodies are commonly govern'd in all their Actions upon one another, and which they inviolably obſerve in all the Changes that happen in the natural State of things. But here we are to diſtinguiſh between the Laws of *Creation* and thoſe of *Nature*, for not only the great Bodies of this Univerſe, but the inferiour *Machins* thereof, were formed by a different Law from what they are now govern'd. For none of the *Laws* of *Motion* or *Nature* now eſtabliſh'd, will any way ſerve to account for the *Production*, *Figure*, *Size*, *Motion* or *Number* of the *Great Bodies* of the Univerſe. nor of their *Appendages*, tho' they may help us a little to conceive their *Appearances*, now they are Created, and put in regular and beautiful

Motions. But this will be more diſtinctly explain'd afterwards.

§ III. That there is no ſuch thing as an *Univerſal Created Soul* animating this vaſt Syſtem according to *Plato*, nor any *Subſtantial Forms* according to *Ariſtotle*, nor any Omniſcient *Radical Heat* according to *Hippocrates*, nor any *Plaſtick Virtue* according to *Scaliger*, nor any *Hylarchic Principle* according to *Henry Moor*, is evident from the following Conſiderations; 1. Theſe (as they are now generally underſtood, tho' perhaps a juſt and true Senſe might be put upon them) are meer *Allegorical* Terms coin'd on purpoſe to conceal their Author's Ignorance When ſome *Philoſophers* cou'd not account for the appearances of Nature, they were ſo far from owning any want of Knowledge, that to keep up their Credit with the thoughtleſs and credulous part of Mankind, they attributed theſe unaccountable Effects, to unintelligible Beings of their own Contrivance, which neither had Foundation nor Exiſtence in Nature: But whoever will give themſelves the leaſt trouble to conſider the Matter, will plainly ſee, that they really meant nothing by thoſe amazing Terms, but to diſguiſe their own Ignorance. 2. Theſe deputed Beings (as they are commonly underſtood) are derogatory from the Wiſdom and Power of the *Author* of *Nature*, who doubtleſs can govern this *Machin* he cou'd create, by more direct and eaſie Methods, than employing theſe ſubſervient *Divinities*. 3. The Appearances themſelves, to ſalve which they were contriv'd, may be by more intelligible and leſs indirect Principles accounted for, as in ſome meaſure ſhall be afterwards ſhown. And Beings are not to be multiply'd without a plain Neceſſity. 4. Laſtly, Theſe very *Beings* will not ſerve the deſign of their Creation, unleſs we endow 'em with Powers and Faculties above the Dignity allow'd by their *Authors*, to ſuch ſecondary Agents.

I do not here intend, to inſinuate any thing againſt the Miniſtry of *Angels*, or the Adminiſtration of *Subordinate Spirits* in the *All-Wiſe's* Government of the World, and in the Works of his Providence: on the contrary, I think *that* more certain, than any thing in our Philoſophy, diſcoverable by the meer uſe of Human Faculties can be, ſince even moſt of thoſe *Appearances* which we account for from our Philoſophick Principles, may, for ought we are abſolutely certain to the contrary, be owing to them. But as we are not to have recourſe to *their* Agency, without plain Neceſſity, ſo *they* were never intended by the Inventers of theſe *Secondary Agents* I have been now diſproving: on the contrary, by theſe, as they are commonly underſtood, are meant ſome Lifeleſs, Independent, Fanciful Powers, Principles, or Faculties unintelligible in true *Philoſophy*, and inconſiſtent

ſiſtent with reveal'd Religion, though perhaps an Explanation may be made of them *congruous* to both.

§ IV. The *Scheme* of *Nature* which ſeems moſt agreeable to the Wiſdom of its Author, according to the modern Diſcoveries, is (ſuppoſing the *Syſtem of the Univerſe* already created) that he has ſettled Laws, and laid down Rules, conformable to which natural Bodies are govern'd in their Actions upon one another, and according to which, the Changes in the material part of this *Syſtem* are brought about, which all Bodies inviolably obſerve, and which of themſelves naturally acting, they never tranſgreſs in the leaſt degree, whilſt *God Almighty* by his *intimate* Preſence, in, and with every ſingle part of the Univerſe, preſerves them in their Faculties and Operations. All the *Integral* Parts of *Nature*, have a beautiful *Reſemblance*, *Similitude*, and *Analogy* to one another, and to their Almighty *Original*, whoſe Images, more or leſs expreſſive according to their ſeveral Orders and Gradations, in the *Scale* of Beings, they are; and they who are Maſters in the noble Art of juſt *Analogy*, may from a tolerable Knowledge in any one of the *Integral* Parts of Nature, extend their Contemplations more ſecurely to the whole or any other *Integral* Part leſs known. Thus this great *Machine* of the Univerſe has a Reſemblance to the leſſer One of a *humane Creature*; for, as in the laſt, the vital Functions are perform'd form'd by general and conſtant Laws; the *Food* is concocted, the *Heart* beats, the *Blood* circulates, the *Lungs* play, the *Secretions* are made by the Laws of Motion, and the conſtant Rules of *Action* of the leſſer Bodies upon one another; So the great Bodies in the ſeveral *Syſtems* of the Univerſe, move in their *Orbits*, turn about their *Axes*, and act upon one another according to the eſtabliſh'd Laws of Motion, and the great Principles of Activity, of theſe greater Bodies upon one another. Again, as the *ſpiritual* Part of the humane Compound, is intimately preſent with, preſides over, actuates and enlivens the whole and each Part of the Body, ſo the *Infinite Creator* and *Governour* of the *Univerſe*, is co-extended with infinite Space, is intimately preſent with every ſingle Point of its Dimenſions, preſides over the Whole and all its Parts, maintains their Being and their firſt impreſt *Energy*. The *Analogy* might be carried to many, and much more ſublime Speculations, but theſe are ſufficient for my preſent Purpoſe, which is to ſhew in the following Sheets, according to my poor Abilities, that the beſt and moſt ſatisfactory Explications of the *Appearances* of Nature hitherto diſcovered, do all evince the neceſſary *Being* and ſpecial *Providence* of God *Bleſſed for ever.*

§ V. It is not my Deſign here to explain all the particular *Laws of Motion*, and of the Actions of Bodies upon one another, nor cou'd it be well done in ſo narrow a Compaſs as I have propoſed to my ſelf; I ſhall here only ſet down the General *Laws of Nature*; which virtually include theſe others, and infer ſuch Concluſions from 'em as I find moſt neceſſary for clearing ſome parts of the following Diſcourſes.

LAW I.

ALL Bodies perſevere in the ſame State of Reſt, or of moving forward in a ſtrait Line, unleſs forc'd out of that State by ſome outward impreſt Violence, *that is*, all Bodies at reſt will naturally, and of themſelves for ever continue in Reſt, unleſs ſome external Cauſe put 'em in Motion: And all Bodies in motion will naturally move forwards for ever in the ſame ſtrait Line, unleſs they are ſtop'd by ſome oppoſite Force, or turn'd out of their Courſe by ſome differently directed Violence.

§ VI. To ſhew how inviolably this Law is obſerv'd by natural Agents, we need only conſider it never has been obſerv'd that any Body did of it ſelf bring it ſelf from Reſt to Motion, nor that ever any Body in Motion brought it ſelf to Reſt; Nor that ever any Body in Motion, of it ſelf altered its Courſe, but that whereever ſuch Changes happened, there were always evident Cauſes. If Bodies chang'd their places of themſelves, all Things wou'd run into Confuſion, nor wou'd there be any certain Means to regulate the *Motions* of the Univerſe. We are certain *Projectils* wou'd for ever move on in the ſame right Line, did not the Air, their own Gravity, or the Ruggedneſs of the Plane, on which they move, ſtop their Motion; or did not ſome Body with a different Direction alter their Courſe. A Top whoſe parts, by their Coheſion, hinder one anothers rectilinear Motions, wou'd never ceaſe to turn round did not the Air gradually impair its Motion. Natural Bodies conſiſt of a Maſs of Matter, which by it ſelf can never alter its State, and if Bodies are once at reſt, they muſt continue ſo, unleſs ſome new Force put 'em in Motion. If in Motion, the ſame *Energy* will continue 'em in Motion and drive 'em forwards in the ſame Directions.

§ VII. Moreover, there is in Matter a paſſive *Principle*, which Sir *Iſaac Newton* very well expreſſes by the *vis inertiæ*, whereby Bodies reſiſt to the utmoſt of their Power, any change or alteration of their State, whatever it be, either of Reſt, Motion, or its Direction; And this Reſiſtance is always equal in the ſame Body, and in different Bodies is proportional to the quantity of Matter they contain. There is required as much Force to ſtop a Body in Motion, as is required to put it in Motion, and è *contra*; And therefore ſince the ſame Body equally reſiſts the contrary equal Changes of its

State, this Reſiſtance will operate as powerfully to keep a Body in Motion as to keep it at Reſt, and conſequently of it ſelf, it can never change its State of Reſt, Motion, or Direction; for to change its Direction, is the ſame thing as to move of it ſelf another way. Matter then of it ſelf is ſo far indifferent to Motion or Reſt, that it is no more inclin'd to the one than to the other, and does no leſs Reſiſt a change from Reſt to Motion, than from Motion to Reſt. This *vis inertiæ* is no where more conſpicuous than in the ſudden Motion of a Veſſel full of Liquor upon a Horizontal Plane, at firſt while the Veſſel is moving along the Plane, the Liquor ſeems to move with a Direction contrary to that of the Veſſel, the Water riſing on the hinder ſide of the Veſſel. Not that there is really any ſuch Motion impreſs'd upon the Liquor, but that by the *vis inertiæ*, the Water endeavouring to continue in its State of Reſt, the Veſſel can't immediately communicate its Motion to it, by reaſon of its Bulk and fluid State; But the Liquor perſeveres in its State of Reſt, whilſt the Veſſel makes forwards and ſo ſeems to move a contrary way. But when once the Liquor has the Motion of the Veſſel intirely communicated to it, and begins to move with a Velocity equal to that of the Veſſel, if the Veſſel be ſuddenly ſtop'd, the Liquor continues its Motion and daſhes over the ſides of the Veſſel. This *Paſ-*

ſive Principle or *vis inertiæ* is eſſential to Matter, becauſe it neither can be depriv'd of it, nor intended or remitted in the ſame Body, but is always proportional to the quantity of Matter Bodies contain.

Corollary 1.

§ VIII. Hence it is evident that no Particle of Matter, nor any Combination of Particles, *that is*, no Body, can either move of themſelves, or of themſelves alter the Direction of their Motion; Matter is not endow'd with Self-motion, nor with a Power to alter the Courſe in which it is put, it is meerly paſſive and muſt for ever of it ſelf continue in that State and that Courſe that it is ſettled in; and if it can't move of it ſelf, it can never alter its Courſe of it ſelf when in Motion, for to alter its Courſe of it ſelf, is only to move of it ſelf after a particular manner.

Corollary 2.

§ IX. Hence it is Evident, that no Body put in Motion will naturally, and of it ſelf move in a *Curve Line*. All Motion is naturally forward in the ſame ſtrait Line with the Direction of the moving Force; but what ever moves in a Curve Line muſt in every Point alter its Direction, and therefore naturally of it ſelf, no body can move in a *Curve Line*. Co-

Corollary 3.

§ X. Hence the great Bodies of this Univerſe the *Planets*, their *Satellits*, and the *Comets* do not naturally and of themſelves (tho' at firſt put in Motion) move in their reſpective Orbits, which are *Curve-Lines* returning into themſelves, but are kept in them by ſome attractive Force, which if once ſuſpended, they wou'd for ever run out in right Lines, and conſequently the Motions of theſe Great Bodies in their *Orbits* do abſolutely depend upon this attractive Force, whenceſoever it ariſes.

Corollary 4.

§ XI. Hence neither Motion nor Reſt (I mean not one of 'em particularly) is eſſential to Matter, *i. e.* Matter is indifferent as to either of theſe particularly, and does as much reſiſt its being chang'd from Reſt to Motion, as it does the being chang'd from Motion to Reſt. And as any Force will imprint ſome degree of Motion on a *quieſcent* Body, ſo the ſame degree of Force impreſs'd at the ſame time with a contrary Direction, will bring it to Reſt again, but it is not neceſſary to the *Being* of Matter that it be in Reſt or Motion, for Matter will be ſtill Matter in which ever of theſe States it be. In a Word, ſince the formerly mentioned paſſive Principle or *vis inertiæ* is eſſential to Matter, it thereby becomes indifferent as to Motion or Reſt, and is equally ſuſceptible of either according as the extrinſic Force urges it.

Corollary 5.

§ XII. Hence the Neceſſity of a *Vacuum*, or ſpace diſtinct from Matter, is clearly demonſtrable; for ſince by their *vis inertiæ*, all Bodies reſiſt to the utmoſt of their Power, any Change or Alteration of their State, whether of Motion or Reſt; and ſince the Reſiſtance in the ſame Body is always equal, or the ſame; and in different Bodies is proportionable to the Quantity of Matter they contain; and ſince conſequently, if two Bodies containing equal Quantities of Matter, and moving with equal Celerities in contrary Directions, ſo that they impinge directly upon one another, will certainly both reſt or ſtop at the Point of their Concourſe, as alſo ſince it is demonſtrable, that two Bodies moving contrary wiſe with equal Celerities, and both reſting at their meeting, are equally Heavy; it neceſſarily follows, that two Bodies containing equal Quantities of Matter, are equally Heavy, and therefore were there no Vacuities in Bodies, two Spheres of equal Diameters, ſhould contain equal Quantities of Matter, and conſequently be equally Heavy, *i. e.* two Spheres of equal *Diameters*, one of Gold, another of Wood, ſhou'd have the ſame ſpecifick Gravities, which being contrary to Experience, there is a Neceſſity of admitting Vacuities in the latter Sphere to anſwer the Difference of their Gravities.

It is true, it may be here anſwered, that one of the equal Bodies may be ſuppos'd to be more *poroſe* than the other, and the Pores to be pervaded by a ſubtle Fluid, which paſſing freely through the Bodies, is not concern'd in the *Impulſe*. And to obviate this Objection, and conſequently to make this proof of the Neceſſity of a *Vacuum* amount to a Demonſtration, Sir *Iſaac Newton* has ſhewn from many repeated Experiments by *Pendulums*, in Air, Water, and Mercury; and more exactly by Experiments on heavy Bodies falling in Air, and Water; that the *Reſiſtance* of Fluid Bodies is always proportional to their *Denſities*, that is to the Quantities of Matter they contain, or their *Vires Inertiæ*. The *Reſiſtance* in Fluids ariſes from their greater *Preſſing* on the Fore, than Hind part of the Bodies moving in them; and this muſt be always in all Fluids proportional to the Quantity of Matter they contain, which preſſes on theſe ſides, that is, their *Denſity*. Bodies moving in Fluids preſs upon and excite a Motion in the Fluids in their paſſage; and this Motion thus impreſſed ariſes from the exceſs of the *Preſſure* of the Fluid upon the fore-part, above that *Preſſure* on the hind-part of the moving Bodies; and this exceſs of *Preſſure* of Bodies in Fluids, will not only raiſe a Motion in them, but will alſo act on the Bodies themſelves, by retarding their Motion, according as it is greater or leſs, whence the *Reſiſtances* of Fluids ariſe; wherefore the *Reſiſtances* of Fluids, are as the Quantities of Matter they contain, or their *Denſities*, which alone can make the Exceſs greater or leſſer. It is true, there is a Reſiſtance in Fluids which may ariſe from their *Elaſticity*, *Glutinouſneſs*, and the Friction of their Parts, *&c.* This *Reſiſtance* may be leſſend and in a great meaſure remov'd by the change of the Figure and Size of their Parts. But theſe Conſiderations have no place in any of the Fluids of our Syſtem, wherein Experiments have been made, it having been always found that their *Reſiſtances* were proportional to their Denſities. So that no *Subtilization*, *Diviſion* of parts, or *Refining* can alter their *Reſiſtances*, theſe depending intirely on their Denſities or *Vires inertiæ*, that is, the Quantities of matter they contain; and the moſt Subtile *Æther* would give the ſame *Reſiſtance* to a Projectile, as *Mercury*, if the Denſity or Quantity of matter were the ſame in the firſt as the laſt: for that being ſuppoſed, the Exceſs of the Preſſure or Weight on the fore-part, above that on the hind-part of the *Projectile* would be the ſame in both, on which alone the Reſiſtances of both depend. Since it is weight alone, that is matter, that can produce *Preſſure* in inanimate Bodies.

Vide Newton. Schol. Prop. XL. lib. 11. *2d. Edit.* From all which it is plain that if Bodies be ever ſo *Poroſe* and fill'd with Fluids ever ſo *Subtile*, yet if there be no *Vacuities* without matter intirely, theſe *Poroſe* Bodies muſt be equally heavy with the moſt compact ones, ſince the Fluids requir'd to fill theſe Pores muſt be equally heavy with the ſolid Body, ſince both muſt contain an equal Quantity of matter if there be no *Vacuities*, all Fluids reſiſting, that is indeed weighing, in proportion to the Quantities of matter they contain. If therefore there be no *Vacuities*, all Bodies muſt be equally heavy, which being contrary to Experience, there is a Neceſſity of admitting *Vacuities*, to account for the different Weights of Bodies.

LAW II.

§ XIII. THE Changes made in the Motions of Bodies are always proportional to the impreſs'd moving Force, and are produc'd in the ſame Direction with that of the moving Force.

Effects are always proportionable to their *adequate* Cauſes, and if any Degree of Force produce any Degree of Motion, a double Degree of the ſame Force will produce a Double Degree of Motion, and a triple a triple, and ſo on; and this Motion muſt proceed in the ſame Direction with that of the moving Force, ſince from this only the Motion ariſes; and becauſe by the former Law, Bodies in Motion cannot change their Direction of themſelves, ſo that unleſs ſome new Force alter its Courſe, the Body muſt proceed in the ſame Direction with that of the moving Force. And if the Body was before in Motion, the Motion ariſing from this impreſs'd Force, if in the ſame Direction, does ſo much increaſe the former Motion; if it has a contrary Direction, it deſtroys a part of the former Motion, equal to that which is impreſs'd; when it has a Direction oblique to that of the former Motion, it is either added to, or ſubſtracted from the former Motion, according as the Motion ariſing from a Compoſition of theſe two, is determin'd.

Corollary.

§ XIV. Hence it is evident, that in the preſent Conſtitution of things, there can be no perpetual Motion. By a perpetual Motion, I mean an uninterrupted Communication of the ſame degree of Motion from one part of Matter to another in a Circle: not as Bodies put in Motion do for ever continue in the ſame, but in ſo far as they are reſiſted or ſtop'd by other Bodies, but a Circulation of the ſame quantity of Motion, ſo that it perpetually return undiminiſh'd upon the *firſt Mover*. For by this

Law, the Motion produc'd is but proportionable to the generating Force; and all Motions on this Globe being perform'd in a reſiſting Fluid, *viz.* the Air, a conſiderable quantity of the Motion muſt be ſpent in the Communication, on this *medium*, and conſequently it is impoſſible the ſame Quantity of Motion ſhould return undiminiſhed upon the *firſt Mover*, which is neceſſary toward a perpetual Motion. Moreover, the Nature of Material Organs is ſuch, that there is no avoiding a greater or leſſer degree of Friction, though the Machin be formed according to the exacteſt Principles of *Geometry* and Mechanicks, there being no perfect congruity nor exact ſmoothneſs in Nature; the manner of the Coheſion of Bodies, the ſmall proportion the ſolid Matter bears to the vacuities in 'em, and the Nature of the conſtituent Particles of Bodies, not admitting the ſame. Beſides, how very imperfect our moſt finiſhed Mechanick Performances are, a very ordinary *Microſcope* will eaſily diſcover Now theſe things muſt very conſiderably diminiſh the communicated Force, ſo that it is impoſſible there ſhou'd be a perpetual Motion, unleſs the communicated Force were ſo much greater than the Generating Force, as to recompence the diminution made therein by all theſe Cauſes, ſo that the impreſs'd Motion may return undiminiſh'd to the firſt *Mover*. But that being contrary to this Law, it is clear, that the Motion muſt continually decreaſe, till it at laſt ſtop, and conſequently there can be no perpetual Motion in the preſent State of Things.

LAW II.

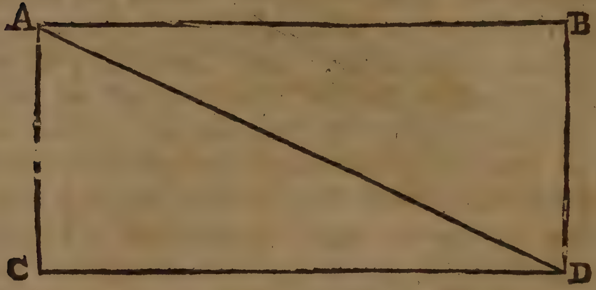
§ XV. REPULSE or Reaction is always equal to Impulſe or Action, or the Action of two Bodies upon one another is always equal, but with a contrary Direction, *i. e.* The ſame Force with which one Body ſtrikes upon another, is return'd upon the firſt by that other; but theſe Forces are impreſs'd with contrary Directions.

Whatever preſſes or draws another, is as much preſs'd or drawn by that other; if one preſſes a Stone with his Finger, the Stone preſſes his Finger again. If a Horſe draw forward a Stone by a Rope, the Stone does equally draw back the Horſe, for the Rope being equally diſtended both ways, act upon both equally. If one ſtrike an Anvil with a Hammer, the Anvil ſtrikes the Hammer with equal Force. The Steel draws the Magnet as much as the Magnet does the Steel, as is evident by making both ſwim in Water; ſo in pulling a Barge to Land by a Rope, the Bank pulls the Barge as much as the Barge does the Bank; and in the deſcent of heavy Bodies, the Stone attracts the Earth as much as the Earth does the Stone; *i. e.* the

Earth gravitates toward the Stone, as much as the Stone does toward the Earth. And the Motions produc'd by both theſe Gravitations, are equal in both, only the Stone is altogether inconſiderable, in reſpect of the Bulk of the Earth, and conſequently the Velocity of the Earth's Motion toward the Stone is inconſiderable, in reſpect of the Stone's Motion toward the Earth, and therefore the Motion of the Earth toward the Stone is inſenſible. And Univerſally in all the Actions of Bodies, if a Body act on another, and change its Motion any manner of way, that other will make the ſame Change in the Motion of this Body with a contrary Direction, ſo that by theſe Actions there are made equal Changes, not of the Velocities but of the Motion, for the Changes made on the Velocities in contrary Directions, are in a reciprocal proportion to the Bodies.

Corollary 1.

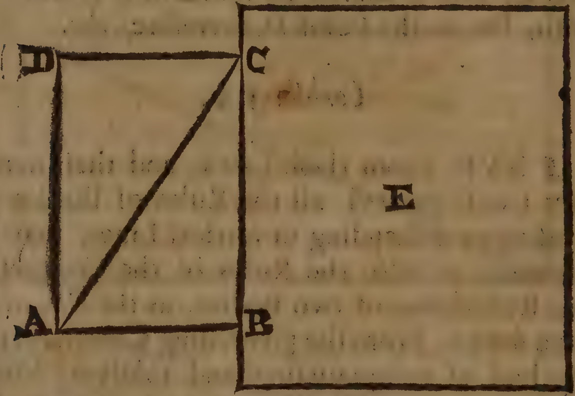
§ XVI. If a Body *A*, be impell'd by two different Forces, one in the Direction *A B*, with the Velocity *M*; another in the Direction *A C*, with the Velocity *N*, make *A B* to *A C*, as *M* to *N* compleat the Paralelogram *A B C D*. the Diagonal of which is *A D*. The Compoſition of both theſe Forces will make the Body deſcribe the Diagonal *A D*, and in the ſame time as it would have deſcribed either of the Sides; for becauſe the Force, whoſe Velocity is *N*, acts in the Direction *A C*, parallel to *B D*, it will not in the leaſt hinder or deſtroy the Velocity in the other Force, by which it tends to the Line *B D*. Wherefore the Body will reach *B D* in the ſame time, whether the Force, whoſe Velocity is *N*, be impreſs'd or not, and therefore in the end of this time it muſt be found ſome-



ſomewhere in *B D*, in like manner, the Force, whoſe Velocity is as *M*, acts in the Direction *A B*, parallel to *C D*, and therefore will not hinder the Velocity in the other Force in proceeding to *C D*, and the Body will reach *C D* in the ſame time, whether the Force, whoſe Velocity is *M*, act or not, and conſequently, in the end of the ſame time, it muſt be ſomewhere in *C D*, but it cannot be found in *B D* and *C D* both, but at the Point *D*, therefore, *&c.*

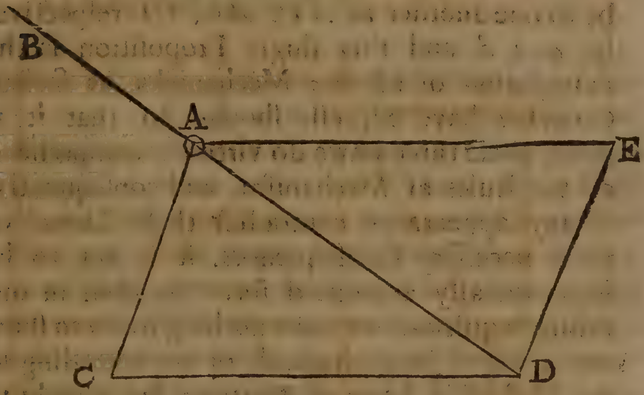
Corollary 2.

§ XVII. From theſe Laws, and their neceſſary Conſequences, all the Rules of Bodies aſcending or deſcending in vertical Lines, may be deduced, as alſo, the Rules of the Congreſſes and Reflections of two Bodies, as the *Geometers* have ſhewn. From the preceeding Corollary, the Method of compounding and reſolving Motions in any given Directions may be drawn, for Example, (*ſee the former Figure*) the Compoſition of the direct Force *A D*, of any oblique ones, ſuch as *A B* and *B D*, as alſo the Reſolution of the direct Force, into any oblique ones, ſuch as *A B* and *B D*, and likewiſe the *ratio* of an oblique Force to move a Body, to that of the ſame Force coming with a perpendicular Direction to move the ſame Body; for Example, (*ſee the following Figure*) let an oblique Force, as *A C* be impreſs'd upon the Body *E* in *C*, at the Point *C* erect a perpendicular *C D*, and from *A* let fall a perpendicular upon *C D*, and another upon *C B*; then by the former Corollary, the Force *A C* may be reſolved into the two Forces *A D* and *A B*, of which only *A B* has any Energy to move the Body *E*; wherefore the oblique Force as *A C* is to the ſame



Force coming with a perpendicular Direction, as *A B* to *A C*, or as the ſine of the Angle of Incidence *A B* to the Radius *A C*. The ſame is true of the Energy of an oblique Stroke upon the Body *E*, to that of the ſame ſtriking perpendicularly.

From the ſame preceding Corollary, it follows that if a Body *A* be impell'd or drawn by three different Forces in three different Directions *A B*, *A E*, *A C*, ſo that the Body yields to none of 'em, but continues in *æquilibrio*, theſe three Powers are to one another as three right Lines drawn parallel to their Directions, and terminated by their mutual Concourſes. If *A D* repreſent the Force by which the Body *A* is impell'd from *A* to *B*; then will the ſame *A D* re-



preſent the contrary equal Force, whereby it is impell'd from *A* to *D*. But by the former Corollary a Force, as *A D* impelling from *A* to *D* is equipollent to two others, acting in the Directions *A C*, *A E*, to which the other impelling from *A* to *D*, is as *A D* to *A C*, and *A E* or *C D*, reſpectively. So likewiſe two Forces acting in the Directions *A C*, *A E*, and being equipollent to the Force Acting in the Directions *A D*, from *A* to *D* will be to the Force acting according to the Direction *A D*, from *A* to *D*, as *A C*, *A E* to *A D*; and therefore the Forces acting in the Directions *A C* and *A E*, and equipollent to the Force acting in the Direction, *A D* are to this Force acting in the Direction *A D*, as *A C*, *A E*, or *C D* to *A D*, that is, if a Body be urg'd by three different equipollent Powers in the Directions *A B*, *A C*, *A E*, theſe three Forces ſhall be to one another as *A D*, *A C*, *C D* reſpectively, *q. e. d.* and this ſingle Propoſition is the Foundation of all the Mechanicks, as ſeveral *Geometers* have expreſly ſhown; ſo that it is plain, theſe three Laws do virtually comprehend all the Rules of Mechaniſm, and conſequently, if any appearance contradict theſe Laws, or their neceſſary Conſequences, it is not to be Mechanically accounted for. So then in our future Inquiries, we have nothing to do to ſhow any thing is Immechanical, or not according to the eſtabliſh'd Laws of Nature; but clearly to evince, that it contradicts ſome of theſe Laws or their Corollaries.

CHAP.

CHAP. II.

Of Attraction or Gravitation in Bodies, and an account of ſome of the Appearances of Nature, from this Principle and theſe Laws now eſtabliſhed.

§. XVIII. HAving thus explain'd the Laws that uninterrupted *Nature* conſtantly purſues in bringing about her Purpoſes and Effects. I come in the next Place to apply theſe to the moſt ſimple, uniform and regular *Appearances* that have as yet been obſerv'd; and theſe are the Motions of the Celeſtial Bodies. Many repeated Obſervations, and almoſt every ſingle *Appearance* of theſe Bodies, evidently demonſtrate them to revolve in *Curve Lines*, and therefore by the 1ſt Law to be drawn out of their rectilinear Courſe, by ſome extrinſic Force acting on them. Let us then enquire how it comes about, that theſe Bodies do perſevere in their Motions, and do conſtantly move round in the ſame Tracts, without making the leaſt Deviation? Now, that can happen but one of theſe two ways, *viz.* Either by the Force of ſome *Celeſtial* Fluid (call'd a *Vortex*) which carries 'em about, or by ſome *Retentive Central Force* which hinders 'em from running out in ſtrait Lines, when they are once put in Motion by the Fingers of him who fram'd this marvellous *Machin* of a World.

§ XIX. In order to account for the *Celeſtial* Appearances, *Des Cartes* ſuppoſes the Matter of this Univerſe to have been at firſt divided by Almighty God, into innumerable little equal Parts, each endow'd with an equal Degree of Motion, both about its own proper *Center*, and ſeparately among themſelves, ſo as to conſtitute a Fluid; as alſo that ſeveral Collections of theſe Parts, were endow'd with a Motion about different Points (at equal Diſtances) as common *Centers*, ſo as to compoſe different *Vortices*, and that theſe Parts being made round by ſuch inteſtine Motions, did produce *Globules* of different Magnitudes, which he calls the Matter of his *ſecond Element*; as alſo that the ſmall Raſpings and Filings of the Angular Points of theſe *Globules* driven violently many different ways, did make up the Matter of his *firſt Element*; and ſeeing there wou'd be more of this *firſt Element* than was ſufficient to fill the Vacuities between the *Globules* of the *ſecond Element*, he ſuppoſes that the remaining part wou'd be driven toward the *Centers* of the *Vortices*, by the Circular Motion of theſe *Globules*, which did for that reaſon recede from it; and being there amaſs'd in a Sphere, wou'd in the *Center* of every *Vortex* produce a Body like the *Sun*; that the Sun being thus fram'd, and moving about its own *Axe* with the Motion of the reſt of the Matter of the *Vortex*, wou'd neceſſarily throw out ſome Parts of its Matter through the Vacuities of the *Globules* of the *ſecond Element*, which conſtitute the *Vortex*, eſpecially at theſe Places which are diſtant from its *Poles*, receiving by theſe *Poles* as much as it loſes about the *Ecliptick*, and by this wou'd be able to carry round with it theſe *Globules* which are neareſt, with the greateſt Velocity, and the remoter with a leſs; and that ſo of neceſſity theſe *Globules* that are neareſt the *Center* of the *Sun* would be leaſt, for were they greater or equal, they wou'd by reaſon of their Velocity, have a greater centifrugal Force, and therefore recede from the *Center*. Now ſhou'd it happen that any of theſe *Sun-like* Bodies in the *Centers* of the ſeveral *Vortices* ſhou'd be ſo incruſtated and weaken'd, as to be carried about in the *Vortex* of the true *Sun*, if it were of leſs Solidity, or leſs capable of Motion than the *Globules*, towards the extremity of the *Solar Vortex*, then it wou'd deſcend toward the *Sun*, till it met with *Globules* of the ſame Solidity, and capable of the ſame Degree of Motion with it, and being fixt there, it wou'd for ever be carried about by the Motion of the *Vortex*, without either approaching to, or receding from the *Sun*, and ſo become a *Planet*. Suppoſing this true then, we may imagine our *Syſtem* to have been at firſt divided into ſeveral *Vortices*, in the *Center* of which was a lucid ſpherical Body, and that ſome of theſe being gradually incruſtated, were ſwallow'd up by others, more powerful and bigger, till at laſt they were all deſtroyed and carried away by the biggeſt *Solar Vortex*, except ſome few that were thrown off in right Lines from one *Vortex* to another, and became *Comets*. Hence it appears according to this *Syſtem*, that the *Planets* that are neareſt the *Sun*, are leaſt ſolid, which is *Des Cartes*'s Reaſon, why the *Moon* ſhows always the ſame Face to us, becauſe that *Hemiſphere* that is oppoſite to the *Earth*, is ſomewhat more ſolid than the other. As alſo that the Matter of the *firſt Element*, which makes up the Body of the *Sun*, moves with greater Velocity the Parts of the *Vortex*, and the Bodies ſwimming therein, that are neareſt it, than thoſe that are remoter, which is the Reaſon why the *Planets* next the *Sun*, finiſh their Periods ſooner than thoſe that are more remote; and that theſe *Planets* move about their own *Axes*, becauſe they were *Sun-like*, lucid, and revolving Bodies before.

§ XX. Now not to mention the many Defects in the Mechanical Production of this imaginary *Syſtem*, I ſhall only take Notice of the known *Celeſtial* Appearances it contradicts; and the Abſurdities wou'd follow, tho' we ſhou'd allow the Author all that he wou'd have granted. And, 1. It is certain that a *Vortex* produc'd by the Revolution of a *Sphere*, about a giv'n *Axis*, wou'd be propagated *in infinitum*, if nothing

thing did hinder it; and ſeeing there muſt be as many ſuch *Vortices* as there are fixt Stars, one *Vortex* wou'd neceſſarily run into another, and every Particle wou'd be acted by a Motion compounded, of the Motions of all the *Central Spheres*, which is abſurd, and contrary to that Conſtancy and Limitation obſervable in the Celeſtial Appearances. 2. Since the Motion of the Parts of the *Vortices* neareſt the *Center* is ſwifter than that of the more remote, they will preſs upon the exterior Parts, and thereby perpetually communicate ſome part of their Motion to them, and therefore theſe interior Parts of the *Vortex*, will be continually loſing ſome part of their Motion, which never being reſtored, theſe Parts muſt gradually move ſlower, till at laſt the Motion is quite deſtroy'd. 3. According to this *Hypotheſis*, each *Planet* is of the ſame Denſity with the Parts of the *Vortex* in which it ſwims, and is govern'd by the ſame Laws of Motion, and is, as it were, only concreted Parts of the *Vortex*: Now the times of the periodical Motion of Bodies, carry'd about by a *Vortex*, are in a duplicate proportion of the Diſtances from the Center; whereas the Squares of Times of the periodical Motions of the *Planets*, are as the Cubes of the Diſtances from the *Center*, and conſequently the *Planets* cannot be carry'd about by a *Vortex*. 4. If a *Vortex* run out *in infinitum*, then a Body carry'd round by it, wou'd certainly deſcribe a perfect Circle, unleſs ſomething ſolid did hinder it, and therefore, the greater Diſtance there were between theſe ſolid Bounds, or the larger the Baſon were which contains the *Vortex*, in reſpect of the *Orbit* of the Body carryed about in it, the nearer wou'd this Orbit approach to a Circle, *i. e.* The Excentricity of the *Planets* neareſt the *Sun*, would be leſs than that of thoſe more remote, the contrary of which is true, for that of *Mercury* is greater than that of *Saturn*. Moreover, ſince the *Planets* in this *Vortex* wou'd neceſſarily move in Orbits nearly ſimilar to that of the ſides of the containing Baſon, it wou'd follow that the *Aphelia* of all the *Planets* ſeen from the Sun, wou'd be directed towards the ſame fixt Stars: but this too is contrary to Obſervation. Likewiſe the Matter of the *Vortex* (as of every Fluid) when bound up within ſtrait Bounds, muſt neceſſarily move faſter than when enlarg'd in a wider Channel; *i e* The *Sun* ſeen from the Earth, muſt ſeem to move faſter in the beginning of *Virgo*, than in the beginning of *Piſces*, which contradicts Experience. 5. A Body carry'd about in a *Vortex* of the ſame denſity with it, wou'd neceſſarily deſcribe a Circle to whoſe Plane, the Axis of the central Body which produces the Circulation of the Fluid, wou'd be perpendicular; but there is not one *Planet* to the Plane of whoſe Orbit the *Sun*'s Axis is perpendicular. Laſtly, The *Comets* have their Orbits, not only oblique, but ſometimes at right Angles with the Plane of the Ecliptick, ſometimes the Courſe of theſe *Comets* is Diametrically oppoſite to that of the *Sun*; they perſevere in their Motions without any change, they deſcribe equal *Area's* by a *Radius* from the *Sun* in equal times, they enter into the *Vortex* of the *Sun*, all which is impoſſible, if the *Solar Vortex* mov'd round with Force ſufficient to carry theſe vaſt Bodies of the *Planets* along with it.

§ XXI. This *Hypotheſis* is ſomewhat altered and mended by the famous Mr. *Leibnitz*, he accommodates it better to the Celeſtial Appearances, and makes it agree more exactly to the Rules of *Geometry*. He firſt of all ſhows, that all Bodies which in a Fluid deſcribe a *Curve-Line*, are mov'd by the Fluid, for of themſelves they wou'd deſcribe right Lines, and nothing but the Fluid concurs to turn them out of their way. He next ſhows, that every *Planet* is carry'd about by a Motion compounded of two other Motions, *viz* an *Harmonical Circulation* of the carrying Fluid, and a *Paracentrical Motion* of acceſs to, or receſs from the *Sun*. For underſtanding theſe Terms, we muſt obſerve that the *Planets* deſcribe *Area's* by a *Radius* from the *Sun*, proportional to their times. Now the Fluid that carries the *Planets*, muſt of neceſſity circulate ſo as to produce this effect, which cannot be done otherwiſe, than by ſuppoſing innumerable concentrical Orbs of exceeding thinneſs to make up the *Vortex*, every one of which has its own proper way of Circulation, *viz.* thoſe Orbs that are neareſt the *Sun* circulate faſteſt, and the Velocities of the Circulations are every where reciprocally proportional to the Diſtances of the reſpective Orbs from the *Sun*, which will neceſſarily make the *Planet* in whatever part of *Vortex* it is, deſcribe equal *Area's* in equal Times; for theſe *Area's* are in a compounded proportion of their *Radii* or Diſtances from the *Sun*, and a reciprocal proportion of the Arches or Lengths of the Circulations, which in this caſe will make a proportion of equality, and this Law of Circulation of the *Vortex* he calls *Harmonical*. The *Paracentrical* Motion is compounded of two others, *viz.* the *Excuſſory* Impreſſion of the *Harmonical* Circulation, whereby all Bodies moving in a *Curve*, endeavour to recede from the *Center* by the *Tangent*, and the Attraction of the *Sun* or the Gravitation of the *Planet* toward it; and this Mr. *Leibnitz* is of Opinion, ariſes from an Impulſe communicated by the Circulating Fluid. Now ſince the *Planets* move in *Elliptick* Orbits, in one of whoſe *foci* the *Sun* is, and by a *Radius* from the *Sun* deſcribe equal *Area's* in equal Times, which no other Law of a Circulating Fluid, but the *Harmonical* Circulation can account for, we muſt find out a Law for the *Paracentrical* Motion, that may make the Orbits *Elliptick*. The *Excuſſory* Impreſſion of the Circulating Fluid, wou'd throw off the *Planet* from the Center by the *Tangent*. Wherefore the Attraction of the *Sun*, or the Gravitation of the *Planets* towards it, muſt be ſufficient to deſtroy this Effect; and beſides, to make them move in *Elliptick* Orbits, which cannot be brought about, unleſs this Attraction or Gravitation be reciprocally as the Squares of the Diſtances from the *Focus*, which is the Sum of *Leibnitz*'s Doctrine upon this Head.

§ XXII. But even this Account of the Celeſtial Motions is both precarious and inſufficient, for theſe Reaſons. 1. The *Comets*, as was formerly ſaid, have their Orbits, ſome of them very oblique, nay, ſometimes at right Angles with the *Zodiak*, and ſometimes the Courſes of theſe *Comets* are quite contrary to that of the *Planets*: Now the *Comets* deſcribing about the *Sun Area's*, proportional to the times, muſt be carry'd about by a *Harmonically* circulating Fluid, as well as the *Planets*, and thus we ſhould have *Vortices* contrary to *Vortices*, which is very abſurd. 2. This Suppoſition is not only unreaſonable, but diſagreeable to the uniform Simplicity of Nature; nor is there any thing in the Motions of the Heavenly Bodies ſo difficult to explain, as this very *Hypotheſis*, which is introduc'd to account for them. Beſides, 3. In equable Motion, the Times are always as the Spaces directly, and the Velocities reciprocally; but in a Circular Motion, the Spaces in one Revolution are as the *Radii*, and in an *Harmonical* Circulation, the Velocities are as the *Radii* reciprocally, and therefore the periodical Times of a Fluid circulating *Harmonically*, are in the Duplicate Proportion of the *Radii*. Now the periodical Times of the *Planets*, are in Seſquiplicate Proportion, and not a Duplicate Proportion of the Diſtances from the *Center* or the *Radii*, and conſequently the *Planets* cannot be carried about by an *Harmonically* circulating Fluid. To this it may be anſwer'd, that this *Harmonical* Circulation is not continued from *Mercury* to *Saturn*, but is interrupted, and reaches only from *Mercury*'s *Perihelium* to his *Aphelium*, and there breaks off, and begins again at *Venus*'s *Perihelium*, and reaches to her *Aphelium*, and is there again interrupted, and ſo on through the whole Syſtem of *Planets*: But what a ghaſtly and unſightly kind of Deformity there would happen on this Suppoſition? Every one may eaſily ſee, this is not like the uniform and ſimple Meaſures of Nature. Beſides, the *Comets* moving forward in the *Zodiack*, paſs through all theſe Chaſms and Interſtices, and notwithſtanding, move in the ſame manner, as if they were carried by a Fluid, circulating *Harmonically* according to ſome uniform Law, neither do their Appearances ſhew the leaſt Suſpicion of theſe Interruptions.

§ XXIII. It being thus prov'd, that the Celeſtial Bodies do not revolve by the means of any circulating Fluid, they muſt be kept in their Orbits, by ſome *Attractive* Power in the *Sun*, or by ſome gravitating Power in them towards him, which is the ſame thing, ſince it muſt be mutual by the third Law. This Gravitating or Attracting Power of the great Bodies of the Univerſe towards one another, ſome *Philoſophers* endeavour *Mechanically* to account for, from the Action of a Subtile Matter, which violently whirling round the *Sun* in general, the *Earth* and the reſt of the *Planets* in particular, and acquiring thereby a Power of receding from the Center, impels Bodies towards that Center about which the ſtrongeſt Circulation is made; or being driven with an immenſe Velocity in right Lines according to all poſſible Directions, impels the Body according to the Direction of that part of this Subtile Fluid, which is leaſt reſiſted by the interpoſition of other Bodies. And thus, not only Bodies within the Sphere of the *Earth*'s Activity are impell'd towards it, but alſo the *Planets* do gravitate towards the *Sun*, but without entering into the particular manner of the Explication of Gravitation according to this Scheme, there be two or three Objections againſt all the poſſible Accounts of Gravity in particular, or Gravitation in general from the Circulation of a Subtile Matter. 1. It is impoſſible from the firſt Part of this *Hypotheſis*, to account for Bodies gravitating towards a Point, for the Motion *quaquà verſum* in a great Circle of the Sphere, which is alledged to ſalve this Difficulty, is a Contradiction to Nature, no ſuch thing being either conceiveable or poſſible. 2. It is impoſſible to explain whence the Circular Motion of this ſubtile Fluid comes, there muſt be conceiv'd another ſubtile Fluid moving after ſome certain manner to produce the Motion of that Fluid, which is the Cauſe of Gravity, and ſo on in *infinitum*, or elſe we muſt admit its Motion without any Cauſe, which is harder to conceive than Gravity it ſelf. 3. That Matter which is the Cauſe of Gravity, or by whoſe Motion it is produc'd in all the poſſible *Mechanical* Explications thereof, muſt be without Gravity which is abſurd, Matter being every where in reaſon to be ſuppos'd of the ſame uniform Nature, and its Gravity to be always proportional to the Quantity of its ſolid Maſs. For ſince all the Bodies we can make Obſervations upon are heavy, as well as extended and impenetrable, it is reaſonable to conclude ſo of all Bodies whatſoever, elſe all *Univerſal Properties* in Philoſophy muſt be given up: And therefore it is Abſurd to ſuppoſe there are ſome Portions of Matter without that Quality which every Portion of Matter we can make Obſervations on has. 4. Bodies from the Impulſe of a Fluid can only gravitate in proportion to their Surfaces, and not according to their Quantity of Matter, which is contrary to Experience; for we find all Bodies gravitate in proportion to their Solidities, *i.e.* their Quantity of Matter; And tho' this Difficulty may be remov'd, by ſuppoſing Bodies to conſiſt originally of *Cylinders* of infinitely ſmall *Baſes*, for on ſuch a Suppoſition, theſe *Cylinders* wou'd be to one another as their Surfaces, their *Baſes* being nothing, and conſequently, the Gravities of Bodies, which by the Action of this ſubtile Fluid are as their Surfaces, wou'd be alſo as their Solidities, *i. e.* the Quantities of Matter they contain, ſince the Surfaces of the original Particles of Bodies are as their ſolid Contents. Yet this is ſo very hard a *Poſtulate*, to require Bodies to be diverſified, only by the Lengths of their primitive conſtituent *Cylinders*, that I can't ſee how it can poſſibly account for all the varieties of Colours, Taſtes and Smells, and other ſenſible Qualities of Bodies which ariſe from the Diverſities of the Texture and Figure of their conſtituent Parts. But that which in my Opinion, overthrows all ſuch *Mechanical* Accounts, however artfully contriv'd, is that, 5. There ſeems to be neceſſary toward a full Explication of the Appearances of Nature, ſeveral different Conditions of this Univerſal Law of *Gravitation*, which cannot be *Mechanically* explain'd, without ſuppoſing different Syſtems of this Fluid, to move after different Manners, and according to different Laws, which will neither accord eaſily together, nor ſeem like the Limitations and Simplicity of Nature. That there are different

Conditions of the Univerſal Law of *Gravitation*, neceſſarily to be ſuppos'd, ſeems evident from the Nature of Light, as Sir *Iſaac Newton* has explain'd it from certain Experiments; and there are other Appearances in Nature, that ſeem to require Conditions different from that which governs the Motions of the Celeſtial Bodies, and cauſes the inflexions of the Light, as ſhall be afterwards ſhown. Now, to account *Mechanically* for theſe different Conditions of the General Law of *Gravitation*, there muſt of neceſſity be ſuppos'd various and different Syſtems of this ſubtile Fluid, which looks a little odd, eſpecially if we conſider, that is not as yet known how many and how different theſe Syſtems muſt be ſuppos'd, to account for all the various Conditions of this General Law, that may hereafter be diſcovered neceſſary to explain the various Appearances of Nature. 6. Laſtly, this whole Affair is more Naturally and Simply to be accounted for from Principles now to be laid down.

Corollary.

§ XXIV. From what has been ſaid it appears that the Attraction or Gravitation of Bodies toward one another, is not to be *Mechanically* accounted for, and ſince it has been likewiſe ſhown, that the *Planets* cannot continue their Motions in their Orbits, without the Suppoſition of ſuch an Attraction or Gravitation, it is evident, that this muſt be a Principle impreſs'd on Matter by the *Creator* of the World; it is a Principle no ways eſſential to Matter, ſince it is the Source and the Origin of the Celeſtial Motions, as Sir *Iſaac Newton* has demonſtrated. And by the firſt Law of Nature and its Corollaries, no kind of Motion is eſſential to Matter, and therefore Attraction or Gravitation cannot be eſſential to it; it is not a Reſult from the Nature of Matter, becauſe the efficacy of Matter is communicated by immediate Contact, and it can by no means act at a diſtance; for we ſee an Object, becauſe the Light reflected from thence ſtrikes immediately upon our Organs of Viſion, we ſmell, becauſe parts of the odorous Body touch the Nerves of our *Noſtrils*, and univerſally all the other Natural Effects of Material things are perform'd by the meer Impulſe of one Body on another, whereas this Power of Gravitation acts at all Diſtances without any *Medium* or Inſtrument to convey it, and paſſes as far as the Limits (if any ſuch there are) of the Univerſe. And acts, not like *Mechanical* Cauſes, according to the Quantity or the Surfaces of Bodies on which it acts, but in proportion to the Quantity of ſolid Matter which theſe Bodies contain. Beſides, by the firſt Law of Nature, Matter is entirely paſſive in its Nature, and can no more tend to, or draw other Bodies than it can move of it ſelf; likewiſe ſuppoſing this Gravitation of the parts of Matter toward one another deſtroy'd, yet ſtill Matter wou'd be the ſame extended ſolid Subſtance. Moreover, if there were but one indiviſible Part of Matter in being, it could not be ſaid to have this Property, it being a Relative one, and having reſpect only to other Parts which it attracts; whereas Impenetrability or any other of the eſſential Properties of Matter continues with it, ev'n when it becomes indiviſible. On the other Hand, if the whole Quantity of Matter now in being, were *amaſs'd* ſo together, that there were neither Motion nor Vacuities in it, (neither of which Suppoſitions imply a Contradiction; for if any two Particles of Matter can be ſo compacted as to admit no Vacuity between them, then it is no contradiction to ſuppoſe the whole *aggregat* of Matter ſo *amaſs'd*, and we are demonſtrably certain, Motion is not eſſential to Matter) then the whole *Maſs* would either be without this Quality of *Attraction*, or this Quality would be abſolutely uſeleſs or without Effect, which is much the ſame thing in an active Quality, as this of *Attraction* is. Laſtly, as Motion is in ſome Circumſtances, the neceſſary Effect of gravity in Bodies, and in other Circumſtances muſt have proceeded from an original Impreſſion, (as in the *projectile* Motion of the *Planets* along their *Tangents*) and yet is of the ſame abſolute Nature in both Caſes, and certainly, is not *eſſential* to Matter; ſo *Attraction*

ction or *Gravitation* is not *eſſential* to Matter, but ſeems rather an *original Impreſs* which continues in it, by virtue of the *Omnipotent* Activity, in the *Divine Nature* of which it is a *Copy* or *Image* in the low Degree that is ſuitable to a groſs Creature, and ſo may now be reckon'd among the *primary* Qualities of Matter, without which, as it is now conſtituted Matter cannot be, but did not *Originally* belong to it as a *Materia prima.* On all which Accounts, its highly probable that this Univerſal Force of *Gravitation* is the effect of the *Divine Power* and *Virtue* originally impreſs'd on, and by that firſt *Energy* continued in Matter, by which the Activity and Operations of Material Agents are preſerv'd. And this Power of *Gravitation* being thus impreſs'd on Matter, is one reaſon of the Diſtinction between the Laws of *Creation* and *Nature,* for tho' the *Energy* of that firſt Impreſſion does ſtill laſt, and is the Source and Spring of the *Uniformity* and Continuance of the *Celeſtial* Motions, yet its not being eſſential to Matter, nor ariſing from its Nature, is the reaſon why it ought not to be reckon'd among thoſe Laws which ariſe from the particular Texture, Figure and Diſpoſition of Bodies, ſuch as moſt of the Laws of Nature or Motion are. The chief Difficulties that I can find have ſtraitned Learned Men, in admitting this Principle of the Univerſal Law of the *Gravitation* of Bodies upon one another are, 1. That they cannot conceive how this Principle can be

Mechanically accounted for; and they think it *Unphiloſophical* to admit any Principle in the Explication of the Appearances of Nature which can't be thus accounted for. It is indeed in my Opinion certain, that this Principle cannot be *Mechanically* accounted for; for there is no other *Mechanical* Cauſe conceivable, this Principle of the *Gravitation* of Bodies upon one another, can ariſe from, but the Motion of ſome ſubtile Fluid, and were there no other Argument againſt all poſſible Explications of *Gravitation* ariſing from the Motion of a ſubtile Fluid, but this one, *viz.* that thereby theſe Parts of Matter which are the Cauſe of, or produce *Gravitation*, are upon this Suppoſition, deſtitute of Gravity; I ſhou'd think it ſufficient to prejudice any inquiſitive Man againſt ſuch Explications; for it's certain that Nature is uniform and conſiſtent with it ſelf, and wou'd not deprive one part of Matter of ſo Cardinal a Property, with which ſhe had endow'd all the reſt. The whole Foundation of *Natural Philoſophy*, is *Simplicity* and *Analogy*, or a Simple, yet Beautiful *Harmony*, running through all Works of Nature in an uninterrupted Chain of Cauſes and Effects, with proper Limitations of Circumſtances: And if theſe Principles be ſuperſeded, or this Chain broken, we can expect nothing but Abſurdities and Inconſiſtences in *Philoſophy*. But even the admiſſion of ſuch an *Hypotheſis* removes us but one Step further from *Immechanical* Principles,

ciples, for the Cauſe of the Motion of this ſubtile Fluid, which is the Cauſe of Gravity, is it ſelf *Immechanical.* Nor has any Body ever pretended to aſſign any other Cauſe of the Motion of this ſubtile Fluid, but the *Omnipotent Cauſe* of the *Univerſe*; and ſince we muſt of Neceſſity admit the Motion of this ſubtile Fluid, which is the Cauſe of *Gravitation* to be unaccountable without a *Firſt Cauſe*, why may we not rather admit this *Firſt Cauſe* to have impreſs'd this Property in Matter, ſince that this Difficulty is the ſame in both; and that beſides, the firſt Suppoſition is burthen'd with ſeveral Additional ones, to which the ſecond is not liable. There has never been any Syſtem of *Natural Philoſophy* offered to the World as yet, that does not require ſome *Poſtulates* that are not to be accounted for *Mechanically*; the feweſt any one pretends to, are the Exiſtence of Matter, the Impreſſion of Rectilinear Motions, and the preſervation of the Faculties of Natural Agents, which no Man has pretended to account for from Principles of *Mechaniſm*; and the Impreſſion of an *attractive Faculty* upon Matter, is no harder *Poſtulate* than any of theſe; but ſince it is Matter of Fact and Demonſtration, that Matter is in poſſeſſion of this Quality; for we daily ſee, that the Earth draws to its Center all Bodies within its Activity, we muſt allow of it, whether it be to be *Mechanically* accounted for or not; and ſince it is not to be accounted for from *Mechanical* Principles, as I think, I have demonſtrated, we muſt of neceſſity refer it to the Power and Influence of the *Firſt Cauſe* of all things. For Cauſes proceed in a continual *Chain*, from more complex to more ſimple Ones, and at laſt to the moſt Simple; and when we are arriv'd at that Cauſe, we can go no further, elſe that Cauſe would not be the moſt Simple; and this moſt ſimple Cauſe cannot be *Mechanically* explain'd whatſoever it may be, elſe it could not be the moſt Simple: And therefore ſince we muſt admit of *Immechanical* Cauſes, ſince *Gravity* is undeniably the Property of all the Bodies we can make Obſervations upon, and is ſufficient to account for the *Appearances* of all thoſe Bodies that revolve about us, as Sir *Iſaac Newton* has ſhown, there can be no Reaſon for rejecting it, tho' it cannot be *Mechanically* explain'd. 2. Another Difficulty ingenious Men have in the Conception of this Quality in Matter, is, how it can act at a Diſtance without any *Medium* to convey this Action, as of neceſſity it muſt. Now, were there no other Difficulty of the like Nature in Philoſophy but this one, it might ſtumble judicious Perſons; but we know the manner of *Thinking* and *Reflection*, of *Remembring* and *Senſation*, are things not eaſily to be explain'd, and yet we muſt admit them. The Communication of Motion from one part of Matter to another, and ev'n the firſt Production of Matter and

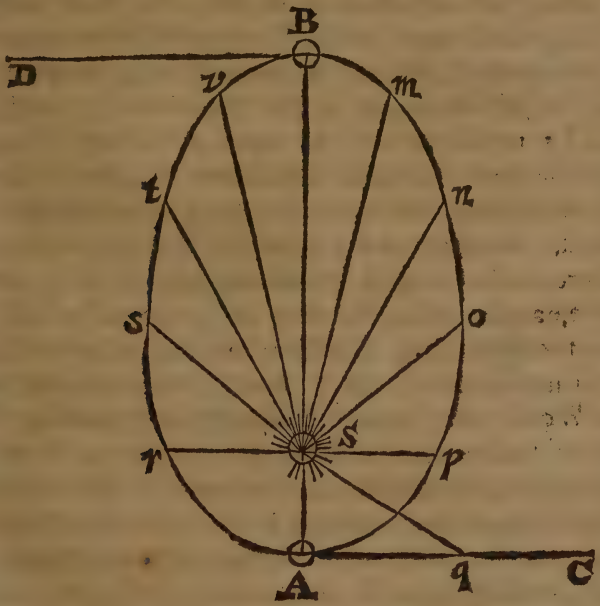
Motion, are not to be accounted for, and yet there is no denying that ſuch things really are, when we are capable to explain how our Souls and our Bodies act mutually upon one another, we may come to be able to conceive how Matter acts at a Diſtance without any *Medium*; but till then, it is ſufficient to know, that ſuch a Quality is actually lodg'd in Matter, and that it is the Cauſe of all the Great and Uniform Appearances of Nature. There is no Contradiction, in ſuppoſing that the ſame Effects may ariſe from Cauſes not altogether the ſame, but that only can be the true Cauſe from which the Effect truly proceeded. Other imaginary or *Hypothetical* Cauſes, have no place in true *Philoſophy*. In *Clocks*, for Example, the Hand on the Dyal-Plate, may be mov'd by a *Spring* or *Weight*; but if a particular *Watch* were propos'd, he wou'd ſay nothing to the Purpoſe, who ſhou'd explain all its Motions by a Spring; when upon looking within it, he might have found a Weight perpetuating the Motion of the Machin, which yet he cou'd not explain by Rules of *Mechaniſm*. No wiſe and honeſt Man, who throughly underſtands the Matter, will offer to explain by Rules of *Mechaniſm*, how this *Syſtem* of things was produc'd, nor how the Faculties of Material Organs are preſerv'd, whence they aroſe, and what way they communicate their Actions and Influences to one another; it will ſuffice ſuch, from the Preſent Appearances to inveſtigate the Powers and Forces of Nature, and from theſe to account for future Obſervations and Appearances; if we admit an *infinitely Wiſe, and Powerful Being* to have made this World, there will be little Difficulty in allowing him to have impreſs'd on Matter what property he pleas'd, and if we will not admit of ſuch a Being, there are much greater and harder Difficulties in the *Mechanical* Explication of the Nature of things to be ſurmounted, as ſhall be afterwards ſhown.

No Body who is but tolerably acquainted with the moſt probable Diſcoveries in Natural *Philoſophy*, can imagine theſe to reach any farther than ſome of the groſſer *Lineaments*, or more conſpicuous *Out-lines* of the Works of the *Almighty*; ſince he muſt be very Ignorant, who can think to ſearch *Him or his Works out, to any tolerable degree of Perfection. Simplicity* and *Harmony* are the ſureſt Marks that the Diſcoveries made are of the true Kind, and *Analogy*, the beſt Rule to make them by. This is ſo evident in the Principle of *Attraction*, that I ſhall here, tho' not its moſt proper Place, obſerve a few *Hints* tending that way. God has moſt certainly implanted ſomething *Analogous* to *Attraction*, in the greateſt *Central* Body of each *Syſtem* towards the leſſer ones of the ſame: Or, a Principle of *Gravitation* in theſe leſſer ones towards the greateſt *Central* one, and towards each other. From hence, and from their directly impreſs'd Motions, all their comely, regular and uniform Revolutions, Appearances and Actions upon one another ſpring. Thus it is in the great Bodies of the Univerſe. Something Analogous to this is the Spring and firſt Mover (at leaſt acting in the Order of God and Nature it ought to be) of all the noble and regular Actions of ſpiritual Beings. God being the *ſole ſovereign, ſelf-exiſtent* and *independent* Being, when he made Creatures partaking of himſelf, Images, *Emanations, Effluxes* and Streams out of his own *Abyſs* of *Being*, could not but impreſs upon their moſt *intimate* Natures and Subſtances, a *Central* Tendency toward Himſelf, an Eſſential Principle of *Re-Union* with himſelf; which in him is a Principle of *Attraction* of them towards him, *Analogous* to this Principle now mention'd in the Great Bodies of the Univerſe. As well might we ſuppoſe an exquiſite Artificer voluntarily producing a piece of Work which ſhould be the Reverſe of his own *Idea:* As well may the *Ray* be ſuppoſed *Diſſimilar* to the Body of the *Sun*, or the *Stream* to the *Fountain-Head*; as that infinite Power and Perfection ſhould produce a *ſpiritual* Creature, that had a neceſſary Tendency to *ſhun* or *fly* away from him, or even be in a ſtate of Indifferency toward him. *Self-exiſtence* and *infinite Power* muſt needs ſubject all Beings to it ſelf, and infinite Perfecti on muſt do it ſo, as muſt be moſt *congruous* to the Nature of the Creatures it produces, in order to make them as happy as they can be made; and therefore God could not make ſpiritual Creatures, but he muſt implant the Principle of *Re-union* in them, in order to bring them back to himſelf, that is, to make them happy: This is the *Origin* of Natural *Probity* and *Conſcience*. It is true, this Principle may be, and in moſt actually is, buried under Matter and Senſuality; extinguiſh'd, as it were, by the more powerful *Attractions* of preſent ſenſible Objects, the Allurements of Carnal Enjoyments, and the violent *Diſtractions* of the Pleaſures of this World; ſo that it is not eaſily perceiv'd, but by thoſe who have for ſome time faithfully follow'd its Direction and *Drawings*. But it is no leſs an eſſential Principle in a *ſpiritual Creature*, tho' thus ſtifled and oppreſs'd, than the Rational Soul is of an *Ideot*, tho' its Operations and Evidence be hindred and obſtructed thro' the inept Organſation of its Body. This Principle of *Re-union* in *ſpiritual* Beings, whenever diſentangled, unfolded, attended to, and regularly follow'd, will as infallibly lead theſe to their proper *Center* of Light and Bliſs, and unite them for ever with it, as the Sun's *Attraction* will bring about the Seaſons and Changes of the Year. On the other hand, if this Principle have not its *Energy* in this Life, when ever the Charms and *Attractions* of Senſe ceaſe, the acquired Principle of *Diſſimilarity* muſt repel theſe Beings with infinite Force from their Centre, ſo that the Principle of *Re-union* being ſet free by Death, and diſintangled, and acting conſtantly, becauſe Eſſential, muſt drive theſe Beings towards God their *Original Centre*, and the Principle of *Diſſimilarity* repelling them, or forcing him to repell them with infinite Violence from him, muſt of neceſſity make them infinitely Miſerable. Thus the future Happineſs or Miſery of *ſpiritual Creatures*, depends on this Principle of *Re-union*, as indeed their preſent does likewiſe; for whatever is in the order of its Nature, that is of God, its Origin, muſt be Happy, ſince he is ſo; and whatever is in a violent or unnatural State, that is, in a State oppoſite to God and Happineſs, muſt be in Miſery. As the Planets diſturb'd by no other *Attractions*, but from their *Central Orb* of Light, and one another, revolve in comely Order and beautiful Harmony, ſhedding their benign Influences on one another: So *ſpiritual Creatures*, following the *Drawings* of the luminous *Centre* of their Being, and giving themſelves up to the Direction of their innate Principle of *Re-union*, enjoy the whole Felicity of their Natures in their preſent State, advance in Purity and Perfection, and in mutual Benevolence and good Will towards one another. For as Motion is the neceſſary Conſequence of *At-*

traction in Bodies that have nothing reſiſting them from without, ſo *Love* and *Benevolence* towards their great *Origin*, and towards one another, is the neceſſary Effect of this Principle of *Re-union* in free Creatures, when unfolded. As the *Vapours*, and even the *Planets* are purified by the *Sun*, and in ſome Senſe made *ſimilar* to, and converted into his Subſtance, by being rais'd nearer to his glorious Body: So *ſpiritual Creatures* are yet more refined, ſpiritualized, and made liker the *Deity*, the nearer they approach to the Fountain of Purity and Perfection, by faithfully following his *Attractions*: which too, like the *Suns*, are powerful and vigorous; infuſe Light and Strength, tho' not ſenſible. In a Word, as the *Attraction* of the *Sun* on the *Planets*, makes them firſt move, and then deſcribe regular *Orbits*, ſo this Divine *Attraction* in ſpiritual Beings, animates the Will, and actuates the Affections, and theſe do all the reſt that is to be done in this preſent State: And as the diſcordant *Attraction* of ſome wandring *Comets* wou'd certainly diſtract and diſorder the *Harmony* of the Motions and Revolutions of the *Planets*, if they approach'd too near them; ſo groſs irregular carnal Affections, earthly and ſenſual *Attractions* admitted too nigh, diſturb and deſtroy the beautiful Progreſs of *ſpiritual Beings*, towards the *Centre* and End of their Being. *Vide* Cap. 2. Part 2.

§ XXV. The great and primary *Law* then, imprinted by the Author of Nature upon all the Bodies of this Univerſe, is that every part of every Body attracts every part of every other Body; and the moſt general Conditions of this Law are, that the *Force* by which one part attracts another in different Diſtances from it, is reciprocally as the Squares of thoſe Diſtances; and that at the ſame Diſtance, the *Force* of the Attraction or Gravitation of one part toward divers others, is as the Quantity of Matter they contain: By the Virtue and Efficacy of this Law, the *Planets* muſt perpetually move in *Elliptick* Orbits, if they meet with no reſiſtance in the Spaces in which they move. For ſince it has been obſerv'd, that all Bodies perſevere in their ſtate of reſt, or moving uniformly in a ſtreight Line, but in ſo far as they are forc'd out of this State, by ſome *foreign Violence* impreſs'd on them; it follows from thence, that Bodies which move in *Curve* Lines, and which are therefore forc'd out of their ſtreight Courſe, which would have been the *Tangents* of theſe Curves, muſt needs be retain'd in theſe *Curve Orbits*, by ſome *foreign Violence* perpetually acting on them. The *Planets* therefore which revolve in *Curve Orbits* (becauſe returning again in the ſame Tract perpetually) muſt neceſſarily have ſome *foreign Violence* perpetually acting on them, by whoſe Influence they are drawn out of their *Tangents*.

Moreover, ſince it is demonſtrated, (*Prop.* 2. *Lib.* 1. *Princip. Phil. Newtoni.*) that Bodies, which move in a *Curve*, on a Plane, and by a Line drawn from them to a Point, fixt, or however moved, deſcribe about that Point *Area's* proportional to their times; are urged or drawn by a Force tending to, or whoſe Direction is toward that Point; and ſince by *Aſtronomical* Obſervation it is certain, that the *primary Planets* about the *Sun*, and the *ſecondary Planets* about the *primary Ones*, deſcribe equal *Area's* in equal times. It is evident, that the Direction of the Force, whereby the *Planets* revolve in their *Orbits*, is toward their *Centers*: and this Force may be very properly call'd *Attractive* in reſpect of the *Central* Body; and *Centripetal*, in reſpect of the revolving Body. Laſtly, Since it is likewiſe demonſtrated, (*Coroll* 6 *Prop.* 4. *Lib.* 1. *Princip. Phil. Newtoni.*) that if Bodies move equably in *Concentrick* Circles, and the *Squares* of their periodical Times be as the *Cubes* of their Diſtances from the common Center; or, if Bodies revolve in *Orbits* that are pretty near *Circles*, and the *Aſpids* of theſe *Orbits* be fixt: then the *Centripetal* Forces of thoſe Bodies, will be reciprocally as the *Squares* of the Diſtances. And that the One of theſe Caſes, or the Other, is Fact, is univerſally acknowledged by all *Aſtronomers*: and conſequently the *Centripetal* Forces of the *Planets*, are as the *Squares* of their Diſtances. Now that we may have a general View, how a *Planet* by the ſame Law, can be made approach to, and recede from the *Attractive* Central Body, which ſeems the greateſt Difficulty in this Caſe; let us conſider the following *Scheme*, wherein let *S* repreſent the Sun. *A o B s*, the Orbit of a Planet *B*, deſcending from *B* to *A*. Let the time of its Revolution



be divided into equal Parts, and then they will be repreſented by the equal *Area's* which are ſuppoſed to be deſcribed by the Line *B S*, drawn through the Body of the *Plauet B*, to the Sun *S* in its ſeveral Stops; *v*, *t*, *s*, *r*, *A* and

theſe

theſe *Area's* will be the *Triangles B S v, v S t, t S s, s S r, r S A.* Now ſince the *Attraction* in *S* encreaſes reciprocally as the *Squares* of the Diſtances, the Velocities of the *Planet* in its deſcending towards the *Sun*, muſt be encreaſed by the encreaſing *Central* Force on it, which muſt make the *Baſes* of theſe *Triangles* larger, that is, the *Arches B v, vt, t s, s r, r A*, muſt ſtill grow longer, as the *Planet* approaches nearer the Point *A.* When it is come thither, it wou'd of it ſelf run out in the *Tangent A C*, make *A S q* equal to *A S p*, equal to *A S r.* Then in the time in which it deſcribed the *Area A S r*, it would, if the *Central* Force in *S* were ſuſpended, deſcribe *A S q* ; but when the *Central* Force acts, it muſt be drawn out of *A q* into *A p*, and deſcribe the *Area A S p*, equal to *A S q* in the ſame time, and ſo of all the other *Area's*, till it aſcend to *B* again, and that perpetually. In a Word, the greater Velocity at *A* than at *B*, wou'd carry the *Planet* much further out in the *Tangent A C*, than in the *Tangent B D*, by which, the *Central* Force acting, it wou'd be carry'd further out in its Orbit in aſcending from *A*, than in deſcending from *B* ; and conſequently, it muſt approach to *S* in deſcending from *B*, and recede from *S* in aſcending from *A*. By Virtue of the ſame Law, and of theſe Conditions, the *Moon* will for ever turn round the Earth, as the Earth doth round the *Sun*, and the *Satellits* of *Saturn* and *Jupiter* round them ; as alſo the *Co-*

mets will in very oblong *Elliptick* Orbits deſcribe about the *Sun* equal *Area's* in equal times; but becauſe the *Sun*, not only attracts the *Planets* and *Comets*, but alſo theſe the *Sun*, and likewiſe the *Planets* attract one another, their Orbits will be ſomewhat irregular, and differ from exact *Ellipſes*, which will be more ſenſible in the Motions of the *Moon*, becauſe She is ſo near to us; and this one Conſideration well apply'd, will account for all the Irregularities hitherto obſerv'd in the Celeſtial Appearances, as Sir *Iſaac Newton* has ſhown; likewiſe, ſince a great part of this our Globe is covered over with Water, it is plain, that by the joint Force of the Attraction of the *Sun* and *Moon*, the Water that lyes directly under them, will be rais'd above its ordinary Level, which will likewiſe happen if they are directly in the oppoſite part of our Globe, becauſe the remoter parts of the Water will be leſs attracted than the nearer, and the Motions produc'd in the Waters by the Attraction of theſe two *Luminaries* can't be obſerv'd ſeparately, but their Forces make up a compound Motion, which at New and Full *Moon* is greateſt, and leaſt at the *Quadratures*, and theſe effects are variouſly limited by the different Diſtances of theſe *Luminaries* from the Earth, their *Declinations* from the *Æquator*, the various *Latitudes* of Places, and alſo the different Situation of the *Shores*, *Banks* and *Bays* of the *Sea*. By this Gravitation, Bodies on this Globe will preſs towards its Center, tho' not exactly thither neither, by reaſon of the *oblate ſpheroidical* Figure of the Earth ariſing from its diurnal Rotation about its Axis. Thus we ſee this one Principle will account for all the great and conſtant Appearances of Nature, and none but this will exactly anſwer any one, much leſs them all, which is a Demonſtration of its Truth. And were not our Terreſtrial *Phyſiology* more complicated than the Celeſtial, (by reaſon of the multiplicity of different Attractions proceeding from the many different Bodies that ſurround any particular one) we ſhould doubtleſs ſee the Extent of this Principle, in accounting for the more minute, and leſs conſtant appearances on this our Globe, as in a great many we actually are. Add to theſe Conſiderations, that we are certain by the Effects, that the Gravitation by which the *Planets* are kept in their Orbits, and by which the *Moon* turns round the Earth, is of the ſame Nature with that by which heavy Bodies tend toward the Center of the Earth. In the *Moon* the Caſe is plain, for ſince the *Rectilinear* Spaces, deſcrib'd by falling Bodies in the beginnings of their Motions, from whatever Motive Powers they be urg'd or drawn, are *proportional* to theſe Powers. The *Centripetal* Forces of the *Moon* revolving in its *Orbit*, will be to the Force of Gravity on the Surface of the Earth, as the Space the *Moon* deſcribes in deſcending towards the Earth, by its *Centripetal* Force, in a ſmall portion of time, if it were ſuppos'd depriv'd then of *Circular* Motion, to the Space, a heavy Body wou'd deſcribe in the ſame time by its own Gravity, near the Surface of the Earth. The firſt of theſe Spaces, is equal to the *verſed Sine* of the *Arch* deſcrib'd by the *Moon* in that time, for that is the Meaſure of the Tranſlation of the *Moon* out of its *Tangent*, by this *Centripetal* Power, which may be computed from the time of its *Periodical* Revolution, and its Diſtance from the *Center* of the Earth being given. The other Space is evident from the Experiments on *Pendulum's*; and when the juſt Calculation is made from theſe Principles, the firſt Space to the ſecond, or the *Centripetal* Force of the *Moon* revolving in its Orbit, to the Force of Gravity on the Surface of the Earth, will be found as the *Square* of the *Semidiameter* of the Earth, to the *Square* of the *Semidiameter* of the *Moon's* Orbit. But in the former part of the Section it has been ſhown, that the *Centripetal* Force of all the *Planets*, was reciprocally as the *Squares* of their Diſtances. Therefore the *Centripetal* Force of the *Moon* near the Earth's Surface, is equal to the Force of Gravity, and conſequently it is the ſame Force in both; for were they different Forces, Bodies by the united Forces of the *Moon* and Earth, wou'd fall with double the Velocity they now do: It is plain then, that the *Centripetal* Force whereby the *Moon* is drawn out of its *Tangent*, is the very ſame Terreſtrial Gravity (whereby Bodies deſcend near the Earth,) which reaches to the *Moon*; and ſince the Revolutions of the *primary Planets* about the *Sun*, and of the *ſecondary Planets* about their primary Ones, are Appearances of the ſame Nature with that of the *Moon* about the Earth, ſince it has been ſhown that the *Centripetal* Forces of the primary *Planets* are directed towards the *Sun*, and the *Centripetal* Forces of the ſecondary *Planets* towards their primary Ones, as the *Moon's* is towards the Earth; Laſtly, Since all their *Centripetal* Forces are reciprocally as the Squares of their Diſtances, we muſt conclude the Natures of their Gravitation to be the ſame in them all, and that they all Gravitate towards one another. For ſince Action and Reaction is mutual, and ſince the *primary Planets* gravitate towards the *Sun*, as alſo the *ſecondary Planets* tend toward the Primary ones as the Center of their Motions; and ſince the Decreaſe and Increaſe of this Gravitation, is of the ſame Nature with that of our Terreſtrial Gravity; ſince likewiſe the *Sun* diſturbs the Motion of the *Moon*, and the *Sun* and *Moon* thoſe of our *Earth*, it is plain they all, *Sun*, *Moon*, *Planets* and their *Satellits*, mutually gravitate upon one another.

§ XXVI. Having thus in the General, eſtabliſh'd the *Laws of Nature*, and deduc'd ſuch Conſequences from 'em as we found neceſſary to clear ſome Parts of the following Diſcourſes; having likewiſe ſhown the Neceſſity of admitting the Univerſal Law of *Gravitation* to ſolve the Celeſtial Appearances, and hinted the great Uſe of this Principle in the Celeſtial *Phyſiology*, let us next proceed to ſome of the moſt *Univerſal* of our Terreſtial *Phænomena*; and firſt of all, let us enquire into the Nature and Cauſe of Fluidity, which ſeems to conſiſt principally in the *Mobility* of ſome parts, without carrying along with 'em the reſt, or the eaſie ſlipping of ſome Parts upon others unmov'd, at leaſt, not mov'd after the manner of ſolid Bodies. All the Bodies in the Univerſe are Originally compounded of ſolid Parts, tho' not indiviſible, yet very ſmall and firm; and Fluids muſt neceſſary take in theſe four Conditions. 1. That their Parts be extremely little; in our common Fluids it is certain that no Eye, however aſſiſted, has been able to perceive their Magnitude; we have been able to diſcover the Figures of Bodies ſwimming in Fluids, but no one as yet has been able to diſtinguiſh the *Figures* or *Magnitudes* of the conſtituent Parts of *Liquors*. 2. That their Figures be *ſpherical*, or at leaſt *ſpheroidical* or approaching to one of theſe, ſo that they may touch only in a Point, and by conſequence, one Particle may eaſily ſlip upon another, and for that End, 3. They muſt be exactly ſmooth and poliſh'd, and ſubjected to the Univerſal Law of

Gravitation, whereby each Particle of the Fluid attracts another, whence that coheſion in the Parts of the fineſt natural Fluids proceeds; but their Gravity muſt be ſuch, that the Force thereof may eaſily exceed the Force of their Coheſion; and here we are to diſtinguiſh between theſe Fluids, generated by the Force of the Fire, and thoſe that are naturally ſuch, there being no neceſſity of attributing any particular Figure to the Parts of the firſt Kind, which owe their Fluidity to the Force of the Particles of Fire, which tear aſunder the Parts of ſolid Bodies, and keep 'em in a perpetual Agitation, and thereby make 'em appear in the Form of a Fluid; whereas the Appearances of natural Fluids do neceſſarily require the Conditions in their Parts juſt now aſſign'd. 4. The Particles of natural Fluids muſt be ſimilar, of equal *Diameters*, of equal Solidity, and conſequently of equal ſpecifick Gravities, or at leaſt they muſt not widely differ one from another in theſe Qualities, that the Fluid may be *Homogeneous*, and of the ſame uniform Nature; from theſe general Suppoſitions, all the general Appearances may be eaſily accounted for.

§ XXVII. Water ſeems to conſiſt of ſmall, ſmooth, hard, porous, ſpherical Particles of equal *Diameters*, and equal ſpecifick Gravities, which have between 'em ſome Spaces ſo large, and ranged in ſuch a manner, as to be pervious on all Sides. Their Smoothneſs makes 'em ſlip eaſily upon one another; their *Sphericity* keeps 'em from touching one another in more Points than one, by both which, their Frictions in ſliding upon one another is rendered the leaſt poſſible; their Hardneſs is the reaſon why Water is incompreſſible, when the Air lodg'd in it is exhauſted.

§ XXVIII. The *Poroſity* of the Particles of Water (which is ſo great, that a *Cubical* meaſure of Water contains at leaſt forty times more Pores than Parts; for Water is nineteen times lighter than Gold, and conſequently nineteen times rarer than Gold; and Gold will by much preſſure, let Water paſs through it, and ſo may be ſuppoſed to have more Pores than ſolid Parts) accounts not only for the different *Specifick* Gravity between Water and other Fluids, ſuch as *Mercury*; but alſo for its greater Tranſparency than moſt other Fluids, the *Rays* of Light finding an eaſy admittance on all Hands through its pervious Pores, and it ſuggeſts the Reaſon alſo why it is more eaſily concreted into a ſolid Form than other Fluids are. *Cold* and *Freezing*, ſeem to proceed from ſome *Salin* Subſtance floating in the Air; we ſee that all Salts, but more eminently ſome, mix'd with Ice, prodigiouſly encreaſe the Effects and Force of Cold, we ſee all *Salin* Bodies produce a Rigidity and Stiffneſs in the Parts of Bodies to which they are apply'd, much like the Effects of Freezing;

we know from Mr. *Boyle*'s *Hiſtory of Cold*, that Freezing increaſes the Dimenſions both of Solid and Fluid Bodies; *Microſcopial Obſervations* inform us, that the Figures of ſome Salts, before they ſhoot into Maſſes, are thin double wedg'd like Particles, which have abundance of Surfaces in reſpect of their Solidity, which is the reaſon why they ſwim in Water when they are rais'd once, tho' they be ſpecifically heavier. But this Effect may be more juſtly attributed to the ſame Cauſe that is preſently to be ſhown to be the Cauſe of Freezing, *viz.* to the ſmall Points of the Salts getting into the Pores of the Particles of Water, whereby theſe Salts are ſuſpended in the Water. In Summer, the Heat of the Sun diſſolves the *ſalin* Particles into a Fluid, breaks off their ſlender Points, and by its Action, keeps 'em in a perpetual Motion, ſo that they cannot ſhoot into a ſolid Wedge, and conſequently are not able to produce the *Appearances* of *Cold* upon Bodies; but in Winter they are leſs diſturb'd, and more at liberty to approach one another; and by ſhooting into thoſe *Chryſtals* (as we ſee the Particles of artificial Salts do, when the Liquor is expos'd to the Air) which by both their Extremities, inſinuating themſelves into the Pores of Particles of Water, make 'em cohere, and fix 'em in a ſolid Form. The Dimenſions of freez'd Bodies are encreas'd by the Inſinuations of theſe *Chryſtal* Wedges in their Pores, and the

Particles of congeal'd Water are kept at ſome diſtance from one another, by the Figure of theſe *Chryſtals*, which in Freezing, inſinuate themſelves in their Pores; for as I have before ſaid, theſe *Chryſtals* are obſerv'd to have the Form of a double Wedge, whoſe Extremities are pointed and ſlender, but its Middle broader and larger, ſo that when the Extremities have inſinuated themſelves into the Pores of two watery Particles, theſe *Globules* cannot come to touch, by reaſon of the Largeneſs of the Middle of theſe *Chryſtals*, and ſo theſe Particles in Freezing, are kept at greater Diſtances from one another, than they were when in a fluid Form; and thus the Spaces between theſe ſpherical Particles, become larger and wider than before, which is one Reaſon why Ice becomes *ſpecifically* lighter than Water. But beſides this, there are many little *Volumes* of Air included at ſeveral Diſtances, both in the Pores of the watery Particles, and in the Interſtices form'd by their ſpherical Figures. Now by the Inſinuation of theſe *Chryſtals*, the *Volumes* of Air are driv'n out of the watery Particles, and many of 'em uniting form larger *Volumes*, which thereby have a greater Force to expand themſelves than when diſperſed, and ſo both enlarge the Dimenſions, and leſſen the *ſpecifick* Gravity of Water thus congeal'd into Ice. Hence we may gueſs at the manner, how Water impregnated with *Salts*, *Earths* or *Sulphurs*, which are not eaſily diſſolvible, may form itſelf into *Mettals*, *Minerals*, *Gems*, and other *Foſſils*, the Parts of theſe Mixtures becoming a Cement to the Particles of Water, or getting into their Pores, change 'em into theſe different Subſtances.

Corollary.

Hence it is plain, that the Quantity of Water on this our *Globe* does daily decreaſe, ſome part thereof being every Day turn'd into *Animal*, *Vegetable*, *Mineral*, or *Metallick* Subſtances, which are not eaſily diſſolv'd into their component Parts again; for ſeparate a few Particles of any Fluid, and faſten them to a ſolid Body, or keep 'em aſunder from one another, and they are no more fluid, to produce which, a conſiderable number of theſe Particles are neceſſarily required.

§ XXIX. *Mercury* ſeems to conſiſt of exceeding ſmall, ſmooth, ſolid, ſpherical or *ſpheroidical* Particles; for ſince *Mercury* in ever ſo ſmall Quantities is abſolutely opake, and lets none of the Rays of Light paſs; and ſince, whatever be the Cauſe of Reflexion and Refraction, Light being Material, muſt either make or find a Paſſage through every refracting *Medium*; ſince likewiſe it is probable, that Light does not penetrate through the ſolid Subſtance of the conſtituent Particles of Fluids, but rather through their Pores and the Vacuities form'd by their Orbicular Figures, it's plain therefore, that the Particles of *Mercury* have very few Pores, and if they be *Spherical*, that their Diameters are not much greater than thoſe of the Particles of Light, for theſe Interſtices are as the Cubes of the Diameters of the *Globules*, by whoſe meeting they are form'd; and ſeeing Light cannot paſs through theſe Interſtices, it is plain, that the Diameters of the Corpuſcles of *Mercury* muſt not be much greater than thoſe of Light; and if theſe Corpuſcles be *Spheriodical*, or Oval, their ſhorteſt Diameters muſt not be much greater than the Diameters of the Particles of Light, to form Paſſages for it. The Solidity of the Particles whereof *Mercury* conſiſts, and the ſmallneſs of the Interſtices they leave between them, accounts for that wonderful Gravity of *Mercury*, above other Fluids.

§ XXX. *Air* ſeems to conſiſt of *Spires* contorted into ſmall Spheres, through the Interſtices of which, the Particles of *Light* may freely paſs, and this is the Reaſon why it is ſo light, the ſolid Subſtance of the *Spires* being very ſmall in proportion to the Spaces they take up; their being ſpiral, accounts for the elaſticity of Air; their being ſpherical Particles which gives free Paſſage to any Heterogeneous Matter, accounts for Air's being compreſſible, as alſo how when compreſs'd it retains its fluidity, becauſe ſpiral Spheres, through which another Matter freely paſſes, when compreſs'd, form themſelves into *Spheriods*, or Figures moſt reſembling them. This Account of the properties of *Air*, may perhaps pleaſe ſome; but there is another, which to others ſeems the more genuine; for, if *Air* be ſuppos'd to conſiſt of ſmall Particles, which endeavour to recede from one another, with a Force *reciprocally proportional* to the Diſtances betwixt their Centers; all the Appearances of *Air* may thence be accounted for; for upon this *Hypotheſis* they will compoſe an *Elaſtick Fluid*, whoſe *Denſity* is proportional to its *Compreſſion*, as Sir *Iſaac Newton* has demonſtrated; *Prop.* 23. *Pag.*270. 2*d Edit.* The *Diameters* of the Particles of *Air* ſeem to be greater than thoſe of *Water*; and the *Diameters* of the Particles of *Water*, greater then thoſe of *Mercury*; and that of the *Light*, by far the leaſt of all, as ſhall be afterwards ſhown.

§ XXXI. Other Fluids (beſides that of the *Light*, under which Name I comprehend all that which paſſes under the Name of *Ætherial* or *Subtile Matter*, which I ſhall examine hereafter) ſeem to be compounded of theſe *Primitive Fluids*, viz. *Water*, *Air*, *Mercury* and *Light*; and of Particles of *Salts*, *Earths*, *Sulphurs*, and ſuch like Ingredients, and the Varieties of ſuch mixt Fluids may in the general be thus eſtimated. 1. Suppoſing all other things alike, eſpecially the *Primitive Fluid*, and the Figure of the parts of the Ingredient, the mixt Fluids will differ proportionably to the Magnitude of the parts of the ſolid Body, which mixes with the Fluid; thus Water or *Lymph* mix'd with *Globules* of Fleſh or Blood of a greater *Diameter*, will make a different Liquor from the ſame *Lymph*, mix'd with *Globules* of Fleſh or Blood of a leſs *Diameter*. 2. *Cæteris Paribus*, (eſpecially the Fluid, the Figure, and the Diameters of the mixing Ingredient being the ſame,) the Liquor will differ proportionably to the Difference of the Firmneſs or Softneſs of the Parts of the mixing Ingredient; thus *Mercury* mix'd with *Globules* of *Diamond*, would make a different Fluid from *Mercury* mix'd with *Globules* of Silver or Braſs. 3. All other things being ſuppos'd the ſame, the Fluid will differ proportionably to the Difference of the ſpecifick Gravities of the Particles of the mixing Ingredients; thus a mixture of *Gold* and *Mercury* will make a different Liquor from that of *Mercury* and *Lead*, the Difference of the ſpecifick Gravities being here only conſidered. 4. All other things being ſuppos'd the ſame, the Liquor will differ according to the different Degrees of the Coheſion of the ſolid Parts among themſelves; thus, *Mercury* mix'd with little ſpherical *Magnets*, will make a different mixture from that of *Mercury* mixt with little Spheres of *Lead* or *Iron*. And theſe ſeem to be the *Primogenial* Differences of mixt Fluids; now, not only all theſe may be differently combin'd with one another, and with the four *Primitive Fluids*, but alſo the Figures of the ſolid Parts in the mixture may be infinitely diverſified, (whereas we have hitherto only ſuppos'd all the mixing Solids *ſpherical*) which will make an infinitely infinite Variety of mixt Liquors.

§ XXXII. That *Light* is a Body, or a material Subſtance, ſeems to be evident from theſe Conſiderations. 1. It is progreſſive, and requires a determin'd time to go from one place to another, and is not propagated in an Inſtant, as is plain from Mr. *Romer*'s Reaſonings upon the *Eclipſes* of the *Satellits* of *Jupiter*, (which are confirm'd by the Obſervations of other *Aſtronomers*) whereby he demonſtrates, that *Light* requires about ten Minutes to come from the *Sun* to us. 2. It may be ſtopt or reſiſted in its Paſſage from one place to another, by the Interpoſition of an opake Body, as other Fluids are ſtopt in their Courſes by the Oppoſition of any ſolid Body. 3. It may be congregated within a narrower, or ſcattered thro' a larger Space, as is evident from reflecting *Specula*, and refracting *Burning-Glaſſes*. 4. It may be reflected, and the Determination of its Motion changed like other Bodies, and it obſerves the ſame Law in its Reflexions that other Bodies do, *viz.* the *Angle* of Reflexion is always equal to the *Angle* of Incidence. 5. It may be put out of its Courſe more or leſs, according to the Nature of the *Medium* through which it paſſes. 6. It acts upon the *Organs* of *Animals*, and upon all other Bodies, as other fluid Subſtances do, by ſtriking upon them with a determin'd Force, by communicating a certain Degree of Motion to them, by ſeparating their component Parts, and putting them in Motion; all theſe Effects we daily ſee. 7. It may be confin'd and ſhut up in determin'd Spaces like other Fluids. The Light of the *Sun* will warm and heat other ſolid and fluid Bodies, which Effects, continue when their Cauſe is remov'd; the parts of Light are yearly impriſon'd in Fruits, Plants, and other Vegetables, as we ſee by the Spirits and warm Juices they afford. 8. Laſtly, The parts of Light are endow'd with various *Original Colours*, ſome are *Red*, others *Blue*, others *Yellow*, and ſome *Green*, as Sir *Iſaac Newton* has demonſtrated, and may be ſeen by a *Priſm* applied to the Hole of a darken'd Room through which the *Sun* ſhines. Now all theſe are the Properties of Bodies, and can belong to nothing but Material Subſtances.

§ XXXIII. That the Particles of *Light* are extremely little or ſmall, we may conclude from thence, that they paſs through almoſt all Bodies that are pervious, ſuch as *Chryſtals*, *Glaſſes*, ſeveral *Gems*, and almoſt all Fluids but

Mercury; and that it freely paſſes where no other Fluid, how thin ſoever, can enter, and yet, no Eye, however aſſiſted, has been able to diſcover or diſtinguiſh the parts of the groſſeſt Fluid. But what moſt of all demonſtrates their ſmallneſs, is, that Light may be propagated from innumerable different *Luminous Bodies*, without any conſiderable oppoſition to one another; ſuppoſe a Plate of Mettal (having at the top the ſmalleſt Hole can be made) were erected *perpendicularly* upon a *Horizontal Plane*, and about it were ſet innumerable luminous Objects of about the ſame height with the Plate, at an ordinary Diſtance from it, the Light proceeding from every one of thoſe Objects, will be propagated through this ſmall Hole, without interfering. This will appear by applying a dark Object in a ſtraight Line againſt the Luminous Body, for the Light of this Body will through the Hole be receiv'd upon the dark Body: Now it is impoſſible that ſo many different *Streams of Light* cou'd be tranſmitted through ſo ſmall a Hole, were not the Particles of Light extremely ſmall. Add to this, that were not the Particles of Light extremely little, being extremely ſwift, (*i. e.* more than a Million of times ſwifter than a *Cannon Bullet*, continuing in its greateſt Velocity, as ſhall be preſently ſhown) they wou'd peirce all kinds of ſolid Bodies with almoſt as great Facility as they do Vacuities, whereas we ſee Light regularly reflected from ſome Bodies. Moreover, we find that innumerable different Spheres of Light within our *Horizon*, may be propagated from their ſeveral luminous Centers, without interfering. How many Millions of Candles and *Flambeaux* may we ſee ſending out their *Tides* of Light, without claſhing upon one another, which argues both the Smallneſs of the Parts of Light, and the Largeneſs of the void Interſtices between the Particles of Air and other Bodies.

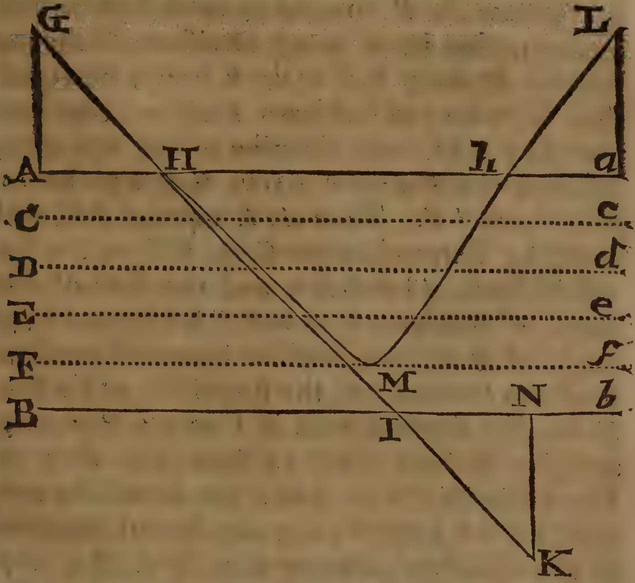
§ XXXIV. How extremely ſwift the Particles of *Light* are, we may gather from the forementioned Experiment of Mr. *Romer*'s, whereby he demonſtrates, that the *Streams* of *Light* paſs from the *Sun* to our *Earth* in about ten Minutes; and *Hugens* in his *Coſmotheoros*, has prov'd, that a *Bullet* continuing in the Velocity with which it leaves the Muſle of the *Cannon*, wou'd require twenty five Years to paſs from us to the *Sun*: Now the *Via Percurſa* being the ſame in both, the Velocities will be reciprocally as the times, *i. e.* the Velocity of Light will be to that of a *Cannon-Bullet*, perſiſting in its greateſt ſwiftneſs, as twenty five Years is to ten Minutes; or as 1314700 to one *Proxime*, ſo that the Velocity, with which the Particles of Light paſs, will be more than a Million of times ſwifter than a *Cannon-Bullet*. Moreover, the Diſtance betwixt the *Sun* and *us*, is at leaſt 12000 *Dia-*

meters of the Earth, but allowing it to be only 10000 *Diameters*, the Light runs a thouſand *Diameters* in a Minute, or ſixteen and half Diameters of the Earth in a Second, or beating of an Artery, that is more than 1100000 *Toiſes*, ſince the *Diameter* of the Earth contains 2865 *French Leagues*; and every *League* contains 2282 *Toiſes*, according to the Numbers of Mr. *Picard.* But Sound goes but about 180 *Toiſes* in a Second, wherefore Light is about ſix hundred thouſand times more Swift than Sound. Likewiſe, ſince the Earth's middle *Diameter* is 7846 Miles, each of which contains 5000 Feet; and ſince Light goes in a Second or in a pulſe of an Artery, ſixteen and a half *Diameters* of the Earth, it is plain, that in every Second it runs at leaſt a hundred and thirty thouſand Miles, which is a prodigious and almoſt an incredible Space in ſo ſhort a time. But the extraordinary Effects of Light and Heat, ſeem to require all this; we ſee how powerfully it acts (being congregated) upon the moſt compact ſolid Bodies, and we never perceive any diminution of its Force ariſing from an abatement of its Velocity.

§ XXXV. The *Sun* and fixt *Stars* ſeem to be huge, denſe Bodies (like the *Earth* or *Planets*) heated to an extraordinary Degree, and their Heat probably may be preſerv'd by the greatneſs of their Bodies, and the mutual Action and Re-action between their Parts, and the

Light which they emit; and their Parts are kept from fumeing away by their *fixity*, and alſo by vaſt Weight and Denſity of the *Atmoſpheres* incumbent upon them, and powerfully compreſſing them, and condenſing the Vapours and Exhalations which ariſe from them. The beſt *Image* we can frame to our ſelves of the *Sun*, is to conceive the Body of the *Sun*, and the *Fluid of Light* ſeparated and apart, (and it is highly probable they may be actually ſeparated, and the firſt intirely drain'd of the latter) the *Sun* then will be like a great *Earth*, only more Denſe, Compact, and Solid. The *Fluid of Light*, like that of *Water* or *Air*, but infinitely more ſubtile, active, and of finer Parts; and that (in compounding them again) the firſt has been ſaturated with, or quite ſwallow'd up in the latter, by which the Parts of the firſt has been put in ſtrong, quick and vehement Vibrations. When the *Sun* and *fixt Stars* are thus diſſolv'd and drench'd in this Fluid, the Light will be emitted from them by the vibrating Motion of their Parts, after the manner we ſee Iron, when heated to ſuch a Degree, as to be juſt going into Fuſion, by the vibrating Motion of its Parts, ſend forth with Force and Violence, copious Streams of liquid Fire all around: great Bodies preſerve their Heat longeſt, and that perhaps in proportion to their *Diameters*. Sir *Iſaac Newton* has made it probable, that the *Comet* which appear'd in 1680, by approaching to the *Sun* in its *Perihelium*, acquir'd ſuch a Degree of Heat, as to be 50000 Years a cooling, whence we may gueſs, that ſuppoſing the *Sun* and fixt *Stars* to be only *Collections* of denſe and ſolid Matter like the *Planets*, heated to a very intenſe Degree, they may be many Millions of Years without loſing any conſiderable part of their Heat. *Aſtronomers* have obſerv'd a cloſe, compact and large *Atmoſphere* about the *Sun*, and there is no doubt to be made, that its Body is of the ſame Nature with the other material Parts of this Univerſe, excepting what Alterations its vehement Heat may produce, and conſequently, its highly probable, that the *Sun* and *fixt Stars* are only *Planet*-like Bodies, vehemently heated.

§ XXXVI. *Bodies* and *Light*, act mutually upon one another, *i. e.* *Bodies* act upon *Light*, in emitting reflecting, refracting and bending its Rays, and *Light* upon *Bodies*, in heating them, and putting their Parts in a vibrating Motion, wherein Heat conſiſts, according to Sir *Iſaac Newton*'s Diſcoveries. If we ſuppoſe that *Bodies* act upon *Light*, by attracting it in Lines *perpendicular* to their Surfaces, *i. e.* ſuppoſing two ſimilar *Mediums* diſtinguiſhed by *Parallel* Lines, and that a Ray in its Paſſage out of the one through the other, is urged *perpendicularly* towards either Plane, by any Force, which at given Diſtances from the Plane, is of given Quantities ; then whatever Inclinations the Rays have to the Plane of *Incidence*, the Sine of the *Angle* of *Incidence* of every Ray conſidered apart, ſhall have to the Sine of the *Angle* of *Refraction* a conſtant *ratio*: In the following *Scheme*, let the ſimilar *Mediums* be diſtinguiſh'd by the two Parallel Lines *A a* and *B b*, which are ſuppos'd to define a *Medium* different from the other two. Let this *Medium* be



divided by parallel pointed Lines *C c*, *D d*, *E e*, *F f*, into ſimilar Planes. Let *G H* be the *incicident* Ray. And ſuppoſe the *refracting Medium A a*, *B b*, begins to act upon it, either when it enters into it at *H*, or at ſome certain Diſtance from it on the one ſide, and ends at a certain

Diſtance from it on the other; and that at all Places between theſe two Limits, the *refracting* Plane acts upon the Ray in Lines whoſe Direction is *perpendicular* to that Plane; and that the Actions upon the Ray at equal Diſtances from the refracting Plane, be equal; and at unequal ones, either equal or unequal, at any *Rate* whatever. If the Impulſe of the *refracting Medium A a B b* on the incident Ray *G H* be uniform, that is, at every Diviſion of the *refracting Medium, C c, D d, E e, F f,* be equal, then according to *Galilæus*'s *Problem,* the *incident* Ray *G H,* will deſcribe in the *refracting Medium,* the *Parabolic Curve G I,* and be *refracted* into *I K.* Take *A H,* equal to *I N,* and erect the Perpendiculars *G A, K N* on the Parallel Planes *A a* and *B b,* and the Sine of the Angle of Incidence *G A,* and *K N* the Sine of the Angle of Reflexion, ſhall be in a conſtant *Ratio* in all the *Incidences* of the Ray *G H,* as Sir *Iſaac Newton* has demonſtrated in *Prop.* 94. *Page* 203. and *ſeq. Princip. Phil. 2d Edit.* and *Prop.* 6. *Pag. Latin Ed. Optic.* And if the Impulſe be unequal on the Ray *G H* at the ſeveral Diviſions of the *refracting Medium C c, D d, E e, F f,* yet ſince it muſt be uniform through every ſingle Diviſion, if theſe be ſuppos'd infinitely little and many, the Propoſition will ſtill hold true, whatever be the Law of the Attraction of the Ray, provided its Direction be Perpendicular to the Plane of the *refracting Medium* and equal, at equal Diſtances from it. And ſince by the 2d *Corollary* of the 3d *Law of Nature*, the oblique Force of the incident Ray *G H*, may be divided into the two Forces *G A* and *A H*, and of the *refracted* Ray *I K*, into *K N* and *I N*; it is evident, that the Velocity of the Ray before its *Incidence*, is to its Velocity after it Emerges; as the *Sine* of *Emergence K N*, to the *Sine* of *Incidence*, *G A*. And if the Velocity of the Ray before its Incidence be greater than afterwards, that is, if the Obliquity of the *Incident* Ray be very Great, in reſpect of that of the *Refraction* when it has enter'd the *Refracting Medium A a B b*, then the *Parabolick* Line will turn back toward the Plane of Incidence; becauſe in that Caſe, the Sine of *Emergence* will grow larger and larger, till it become equal to the *Radius*, and then the *Ray* muſt return ſomewhere at *M* in the *Parabolick* Line *A H m h L*. Take *h a* equal to *H A*, and erect the Perpendicular *a L*, and it ſhall be equal to *A G*, that is, the Sine of *Incidence* ſhall be equal to the Sine of Reflexion, as Sir *Iſaac Newton* has prov'd in the forecited Place of his Principle. Now ſince it is matter of Fact and Experiment, that the *Sines* of the *Angles* of *Incidence*, and *Refraction* in all Rays of whatever Nature, obſerve a conſtant *ratio*, and that the *Angles* of *Reflexion* and *Incidence* are equal; it is therefore on the other hand true, that the Rays of *Light* are thus urg'd by the *Refracting*

Media, and their Velocity thus abated by *reflecting* ones, ſo that it is evident, *Refraction* and *Reflection* proceed from one and the ſame Principle, acting differently in different Circumſtances, that is, when the Obliqnity of the *Incident* Ray is great, and the *Refractive* Power of the *Medium* is alſo conſiderable, the Ray will be reflected. But if its Angle of *Incidence* be large, and the *Refractive* Power of the *Medium*, not very ſtrong to throw it far from the Perpendicular, it will be *Refracted.*

§ XXXVII. Sir *Iſaac Newton* has demonſtrated from plain and convincing Experiments, that the *Light* of the *Sun* conſiſts of Rays differently *refrangible* and *reflexible*, and that thoſe Rays are differently *reflexible*, that are differently *refrangible.* Theſe Rays that are all alike *refrangible*, he calls the *Light* of them Simple and *Homogeneal*, and thoſe that are ſome more *refrangible* than others, he calls their *Light*, Compound and *Heterogeneal*; the greater or leſs *Refrangibility* of Rays, is their Diſpoſition to be turn'd more or leſs out of their way, in like Incidences on the ſame *Medium*; and their greater or leſs *Reflexibility* is their Diſpoſition to be return'd back more or leſs eaſily into the ſame *Medium* from any other, upon whoſe Surface they fall. *Refraction* out of the Rarer *Medium* into the Denſer is made ſo, that the *Angle* of *Refraction* is leſs than the *Angle* of *Incidence*, and on the contrary. The Colours of

Homogeneal Light are theſe, *Violet*, *Indico*, *Blue*, *Green*, *Yellow*, *Orange* and *Red*. Theſe Colours in the Objects are their Diſpoſition to *reflect* this or that ſort of Rays more copiouſly than the reſt; and in the Rays of *Light* they are their Diſpoſition to propagate this or that Motion into the *Organs* of Viſion, and in *them*, they are Senſations of thoſe Motions under the Forms of Colours; the Rays that produce Red Colours, are leaſt *refrangible*, and thoſe that make Violet, the moſt, and the reſt are more or leſs *refrangible*, as they approach either of theſe Extremes in the Order ſet down, that is, Orange is leaſt *refrangible*, next to Red, and Yellow next to Orange, and ſo on. All the Colours of the Univerſe which are made by Light, are either the Colours of *Homogeneal* Lights, or compounded of a Mixture of thoſe: Whiteneſs is produc'd by a due Mixture of all the *Primary* Colours of *Homogeneal* Light; and Blackneſs by a Suffocation, or *Non-reflexibility* of Light; and all Grey Colours, betwixt Black and White, may be compounded of all the *Primary* Colours mixt in a due Proportion; the *Primary* Colours of *Homogeneal* Light are unchangeable in their Nature, and no *Reflexions* nor *Refractions* will change any of theſe into another: whereas by the due Mixture of colour'd Bodies, Colours may be produc'd by Compoſition, which ſhall be like to the Colours of *Homogeneal* Light, but not as to the immutability of Colour; for that may be chang'd according to the Colour of the Light by which they are ſeen; ſo that if the *Sun*'s Light conſiſted but of one ſort of Rays, there wou'd be but one Colour in the whole World, and it wou'd be impoſſible to produce any new Colour by *Reflexions* or *Refractions*, for all the Variety of Colours depends upon the different Compoſition of Light.

§ XXXVIII. The Rays of Light which fall upon Bodies, and are *reflected* or *refracted*, begin to bend before they arrive at the Bodies. Sir *Iſaac Newton* has ſhown by ſeveral Experiments of Rays paſſing by the Edges of Bodies, that they are *incurvated* by the Action of theſe Bodies as they paſs by them, and that this Action is ſtrongeſt at the leaſt Diſtance; he has demonſtrated likewiſe, that the Cauſe of *Reflexion* is not the impinging of Light on the ſolid and impervious Parts of Bodies. For (not to repeat thoſe other Arguments which he has brought in great plenty) ſince Glaſs can be no other ways poliſh'd, than by grating and ſcratching it by Subſtances, whoſe Parts are ſmall and ſubtile, ſo that the Scratches and Frettings of its Surface become too ſmall to be viſible, yet not ſo ſmall as to become truly plain or *ſpherical*, and all together to compoſe one Surface; if Light were *reflected* by impinging upon the ſolid Parts of Glaſs, it wou'd be ſcatter'd as much by the moſt poliſh'd Glaſs, as by the rougheſt, which being contrary to Experience, it is evident, that the Reflexion of a Ray is not effected by one ſingle Point of the *reflecting* Body, but by ſome Power of the Body, which is evenly diffus'd over all its Surface, by which it acts upon the Ray without immediate *Contact*, after the manner hinted § 37. Bodies *reflect* and *refract* Light by one and the ſame Power variouſly exerciſed in various Circumſtances; for when Light goes out of Glaſs into Air as *obliquely* as it can poſſibly do, if its *Incidence* then be made ſtill more *oblique*, it becomes totally *reflected*, for then its *refractive* Power, or the Force of its Attraction upon the Ray, becomes too ſtrong to let any of the Rays go through. Beſides that, thoſe Surfaces of tranſparent Bodies which have the greateſt *refracting* Power, *reflect* the greateſt quantity of Light; for by Experiment it is found, that in the *Superficies* interceding two tranſparent *Mediums*, the *Reflexion* is ſtronger or weaker, as the Superfice hath a greater or leſſer *refracting* Power; for in the confine of *Air* and *Sal-Gem* 'tis ſtronger than in the confine of *Air* and *Water*, and ſtill ſtronger in the confine of *Air* and *common Glaſs* or *Cryſtal*, and ſtronger in the confine of *Air* and *Diamond*. Between the Parts of opake and colour'd Bodies, there are many Spaces either empty or repleniſh'd with *Mediums* of other Denſities, as Water between the tinging Particles wherewith any Liquor is impregnated, Air between the *aqueous Globules*, that conſtitute Clouds or Miſts, and perhaps, *Mediums* different from both theſe between the Parts of hard Bodies. Now *Reflexions* are produced in the *Superficies* which intercede theſe *Mediums* of different Denſities, and the Reaſon why uniform pellucid *Mediums* have no ſenſible Reflexion but at their external *Superficies*, is becauſe all their Parts are of an equal Denſity; and Opacity ariſes from the multitude of *Reflections* produc'd in the internal Parts of Bodies.

§ XXXIX. All Bodies ſeem to have their *refractive* Powers *proportional* to their Denſities, excepting ſo far as they partake more or leſs of ſulphurous, oily Particles, and thereby have their refractive Power made more or leſs; this Sir *Iſaac Newton* has found by Obſervation on almoſt all tranſparent Bodies, together with a Calculation founded upon the Suppoſition, that Light is ſwifter in Bodies than *in vacuo*, in the Proportion of the *Sines* which meaſure the *Refraction* of Bodies, which is certainly true, ſince it's from the Action of Bodies on Light, that this *refractive* Power does ariſe; and it's very probable, that this *refractive* Power in Bodies does moſtly depend upon the ſulphurous Parts with which they abound, ſince all Bodies partake more or leſs of Sulphurs, as by Chymical *Analyſes* we find. And as Light congregated by a Burning-Glaſs, acts moſt upon ſulphurous Bodies, to turn them into Fire and Flame; ſo ſince all Action is mutual, Sulphurs act moſt upon Light: and that the Action between Light and Bodies is mutual, is evident from this Conſideration, that the denſeſt Bodies which *refract* and *reflect* Light moſt ſtrongly, grow hotteſt in the Summer Heat, by the Action of the *refracted* and *reflected* Light. The Bodies that reflect Light, are thoſe whoſe Pores are fill'd with *Mediums* of an unequal Denſity with that of the *refracting Medium* it ſelf, and Bodies become more tranſparent, by filling their Pores with Fluids of equal, or almoſt equal Denſities with their Parts, as Paper dip'd in Water or Oyl: and on the contrary, the moſt tranſparent Subſtances may, by evacuating their Pores, or ſeparating their Parts, be render'd ſufficiently opake, as Salts or wet Paper dry'd, Glaſs by being pulveriz'd, or Horn by being ſcrap'd.

§ XL. The *leaſt Parts* of almoſt all Natural Bodies are tranſparent, as may be ſeen by viewing ſmall Bodies with a *Microſcope*, and conſequently, they muſt, according to their ſeveral Sizes, reflect Rays of one Colour, and tranſmit thoſe of another, upon the ſame Ground that thin Plates reflect or tranſmit thoſe Rays; for a thin Plate of an even thickneſs appears all over of the ſame Colour, and if this Plate were ſlit into *Threads*, or broken into *Fragments* of the ſame thickneſs with the Plate, there is no reaſon why every *Thread* or *Frag-*

ment ſhould not keep its Colour, and conſequently, why a heap of thoſe *Threads* or *Fragments* ſhould not conſtitute a Maſs or Powder of the ſame Colour which the Plate exhibited before it was broken; and the ſmall Parts of all Natural Bodies being like ſo many *Fragments* of a Plate, muſt on the ſame Grounds exhibit their Colours. Now Sir *Iſaac Newton* found by Obſervation, that thin Plates or Bubbles *reflected* Rays of one Colour and *tranſmitted* thoſe of another, according to their ſeveral thickneſs or thinneſs; and therefore the ſmall Parts of Natural Bodies being tranſparent, muſt upon the ſame Grounds *reflect* or *tranſmit* the ſeveral ſorts of Rays: and this is the Foundation of the various Colours of all Natural Bodies. But the parts of Bodies on which their Colours depend, muſt be denſer than the *Medium*, which pervades their Interſtices; and as there is a conſtant Relation between Colours and *Refrangibility*, the moſt *Refrangible* Rays being *Violet*, the leaſt *Refrangible Red*, and thoſe of intermediate Colours having proportionally intermediate Degrees of *Refrangibility*; ſo there is a conſtant Relation between Colour and *Reflexibility*, the *Violet* being in like Circumſtances reflected at leaſt thickneſſes of any Plate or Bubble, the Red at greateſt thickneſſes, and the intermediate Colours at intermediate thickneſſes; and there are ſeveral Orders of thoſe Colours more or leſs intenſe and vivid, according to the ſeveral thickneſſes of theſe Plates or Bubbles: and the reaſon why the Surfaces of all thick and tranſparent Bodies reflect part of the Light incident on them, and refract or tranſmit the reſt, is, that ſome Rays at their *Incidence* are in *Fits* of eaſie *Reflection*, and others in *Fits* of eaſie *Tranſmiſſion.* Thoſe who deſire full Satisfaction in this wonderful Appearance of Nature, muſt go to that late admirable Treatiſe of *Opticks*, written by Sir *Iſaac Newton*; for it is impoſſible to ſeparate the Parts of this Work from one another without Diſadvantage to them, or to ſum them up in a leſs room, without loſing ſomething *New* and *Uſeful.* That great Perſon having before ſhown how far *Numbers* and *Geometry* would go in *Natural Philoſophy*, has now manifeſted to the World to what ſurprizing Heights, even vulgar *Experiments* duly managed and carefully examined in ſuch Hands may advance it. In the general, I think we may ſafely conclude from Sir *Iſaac Newton*'s Diſcoveries. 1. That the *Sun* and *fixt Stars* are but *Planets* or *Earths* vehemently heated; or having their ſmalleſt Parts put in a ſtrong *vibrating* Motion. 2. That Light is emitted from them, by theſe powerful *Vibrations* of their ſmalleſt Parts. 3. That this Fluid of Light emitted from theſe *vibrating* luminous Bodies, requires a certain time in paſſing from them to us, and moves after the ſame manner other Fluids do, only with a much greater Velocity. 4. That Bodies draw this Light to 'em in Lines *perpendicular* to their Surfaces, and that this Light puts the parts of theſe Bodies in a *vibrating* Motion wherein Heats conſiſt. 5. That the Motion of Light is ſwifter in Bodies than *in vacuo*, by reaſon of this Attraction; and ſlower after its being *reflected*, than in its *Incidence*, becauſe that Force of Attraction which accelerates its Motion in its *Incidence*, muſt of neceſſity retard its Motion in its *Reflexion*, by reaſon of the different Direction thereof. 6. That the Ray in its whole Courſe of *Reflexion* and *Incidence* deſcribes a *Curve*, or is rather bended than broken. 7. That the *Vibration* of the ſmaller parts of Bodies produc'd by the Action of Light, when brought to a certain Degree of Strength, is the Cauſe of their Light; juſt as we ſee the *Vibrations* produc'd in the Air by tremulous and ſonorous Bodies, muſt be of ſuch a determin'd Force to produce a diſtinct Sound. 8. That theſe *Vibrations* produc'd in Bodies by the Action of Light, when their Motion conſpires with that of the Rays of Light, *i. e.* when any Ray is in that part of theſe *Vibrations* that has the ſame Direction with that of the Ray, it eaſily breaks through a *refracting* Subſtance, but when it is in the contrary part of the *Vibration*, which impedes its Motion, it is eaſily reflected, and ſo every Ray is diſpos'd *alternately* to be eaſily *reflected* or eaſily *tranſmitted*. 9. That the

Rays of Light are of their own Nature diverſly *Refrangible* and *Reflexible*, and that this diverſity in both ariſes from the ſame Principle, acting differently in different Circumſtances, *viz.* the Action of Bodies upon Light. 10. That *Reflexion* is caus'd by the different Denſities of Bodies, and happens only in *Superficies* that intercede *Mediums* of different Denſities. 11. That Light is totally tranſmitted through *Mediums* only that are of the ſame uniform Denſity, and that the *refractive* Power of Bodies is principally owing to the Sulphurs with which they abound; for ſince all Action is mutual, and ſince Light congregated by a Burning-Glaſs acts moſt upon Sulphurs, ſo Sulphurs ought to act moſt upon Light. 12 That the Forces of Bodies to *reflect* or *refract* Light are very nearly proportional to the Denſities of the ſame Bodies. 13. That certain Colours are ty'd to ſuch Degrees of *Refrangibility* or *Reflexibility*, and that all the *primitive* and *original* Colours depend upon theſe Degrees. 14. That *White* conſiſts in an equal mixture of all the *primitive* Colours, and *Black* in a Suffocation of all the Rays of Light, which is the reaſon why *Blacks* burn more eaſily than other Colours; and other not *primitive* Colours ariſe from a certain mixture of theſe. 15. That the Colours of Natural Bodies depend upon the different Denſity of their ſmall Parts, and thereby their fitneſs to reflect Light of one

Colour and tranſmit that of others. 16. That ſeveral ſorts of Rays make *Vibrations* of ſeveral bigneſſes, which according to their bigneſſes excite Senſations of ſeveral Colours much after the ſame manner, that the *Vibrations* of the Air according to their ſeveral bigneſſes excite Senſations of ſeveral Sounds. 17. That the *Harmony* and *Diſcord* of Colours ariſe from the Proportions of the *Vibration* propagated thro' the Fibres of the Optick Nerves into the Brain, as the *Harmony* and *Diſcord* of Sounds ariſes from the Proportions of the *Vibrations* of the Air.

Corollary.

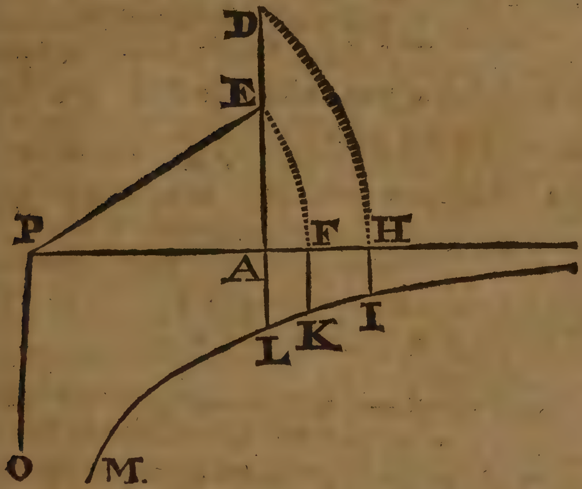
From what has been ſaid of the Nature of the *Sun*, and its *Light*, it is evident, that the Quantity of Heat and Light in the *Sun* doth daily decreaſe; like other vehemently hot Bodies it muſt gradually cool; as alſo, by its *Emiſſion* of ſo many Millions of Rays perpetually, quite round its Body, upon all the *Planets* within its Syſtem, which do not return, both its Bulk and Heat muſt be diminiſhed. It is not improbable that all the virtual Heat in the Juices of Vegetables, Metals and Minerals, may be owing to the Action of the impriſoned Rays in 'em: the Production of Animals in the ordinary way, requires a certain Degree of Warmth, which proceeds from the *Sun*'s Influence. Some Bodies do ſtifle and ſuffocate the Rays of Light, ſo as that they are never, or not duly reflected again. Sulphurous and Bituminous Bodies form little Cells by the Action of the Rays of Heat and Light, to retain 'em. All Bodies burn and emit Flames in proportion to the quantity of *Sulphurs* in 'em. Spirits by frequent Diſtillations may be drawn out of *Vegetable* Juices which ſhall flame and fume away of themſelves in the open Air. Nay, the *Sulphurous* parts of ſome Bodies may be ſo ſeparated from their Salin and Earthy parts, and ſo united, as to continue their Flames and Burnings even when cover'd over with Water; as the liquid and ſolid *Phoſphorus*, which only ſhow their Flames more conſpicuouſly when expos'd to the Air: all which ſhow how readily Light and Fire of all kinds, *Solar* and *Terreſtrial*, are receiv'd by *Sulphurs*, and how cloſely they are united with them; ſo that the Rays of the *Sun* are certainly ſwallow'd up by *Sulphurous* Bodies, and cannot be returned to their Fountain-head. Some have thought, that the Rays and Light of the *Sun* were diſſeminated through the whole Body of the *Atmoſphere*, even when their Fountain was got quite below our *Horizon*, by obſerving, that *Mercury* ſhut up in a *Tube* exhauſted of Air, if the *Mercury* had been firſt well cleans'd, the *Tube* perfectly exhauſted and cloſely ſeal'd up, but not quite fill'd with the *Mercury*, upon ſhaking briskly and frequently the *Tube* under theſe Circumſtances, in a darken'd Room, copious

Gleams of Light would thereby be emitted, ſo as to enlighten the whole Room. But Mr. *Hauksbee* has made it evident, that any Friction with the Hand, or other ſoft Body, on an exhauſted Glaſs, *Sphere* or *Cylinder*, when violently agitated or turned round very quickly, even without the *Mercury*, will produce the ſame Appearance; whereby it is evident, that it is the *Friction* which produces the Effect in both Caſes; the *Mercury* in the Agitations of the *Tube*, raſping the Sides thereof, and ſetting its Parts in proper *Vibrations*, and the Hand or other ſoft Body, cloſely apply'd to the whirling exhauſted hollow *Sphere*, or Glaſs *Cylinder*, producing the ſame effect; the drawing out the Air in both Caſes contributing nothing to the Effect, but as the removing an Impediment to the due *Vibration* of the parts of the Glaſs; as we ſee the Application of any Foreign Body cloſe to a Sonorous Body, will hinder thoſe *Vibrations* which are the Cauſe of its proper Sound; and it is the proper, quick and ſtrong *Vibration* of their Parts, that is the Cauſe of Light in Glaſs Bodies, and all others ſuſceptible of it. But ſince it's certain, that Bodies do attract the Rays of *Light*, and do retain 'em ſo, that they can never return to the Fountain of *Light* again; it's plain, the Quantity of *Light*, both in this *Bright Luminary*, and in the *Sun-like fix'd Stars* muſt be continually decreaſing. There is no Reaſon can be aſſigned ed for doubting, that the *fix'd Stars* are of the ſame preciſe Nature with our *Sun*, and there are ſeveral probable Reaſons can be aſſign'd to ſhow their Similarity; the Light in both is of the ſame Nature, and all the ſeveral *Syſtems* tranſmit their Light into one another: Now it is Fact, that ſeveral *fix'd Stars* have diſappeared for many Years, ſome having again appeared, others never, as is evident from the Obſervations of *Aſtronomers.* And it's not unlikely that theſe diſappearing *fix'd Stars* were actually extinguiſh'd, that their Heat and Light were actually ſpent and exhauſted, and they turned into mere opake and groſs *Planet-like* Bodies, and would for ever continue ſo, if not re-kindled, and new recruited with Heat and Light; the Poſſibility of which, in ſome of the extinct *fix'd Stars*, may be afterwards accounted for. And if this be not very far from the Truth, we have here an undeniable Proof of the Poſſibility of the Decreaſe of Heat and Light in the *Sun.* However, it's alſo certain, that this Decreaſe is very inconſiderable in any ſhort time; tho' we are ſure there is ſome, and our not being ſenſible of this Decreaſe, is only an Argument of the exceeding Smalneſs of the Particles of *Light.* We find ſome *odoriferous* Bodies ſend out Steams for many Years, without ſenſibly diminiſhing either in their Bulk or Weight, which argues the Smalneſs of the Parts of theſe Steams. But the Particles of *Light* muſt be extremely ſmall, ſince the *Sun* for ſo many Ages has been conſtantly emitting *Oceans* of Rays, without any ſenſible Diminution: But this can ſurprize no Body who conſiders that Matter is infinitely diviſible; for it is poſſible to aſſign in Numbers, a Quantity, whereof a Body as big as the *Sun* may conſtantly, for any finite Number of Years emit *Oceans*, and yet the Sum of 'em all may not be greater than a cubical Inch, or even a Grain of Sand.

§ XLI. We have already obſerv'd, that the moſt general Condition of the *Univerſal Law* of Gravitation in Bodies, was, that at the ſame Diſtance from the Center of the attracting Force, Bodies did gravitate in proportion to their Solidity, and at different Diſtances, *reciprocally* as the Squares of thoſe Diſtances; but this Condition may not be ſo general, as altogether to exclude others: The way to know how this *Univerſal Law* is diverſify'd, in the different Bodies, is to obſerve what Lines Bodies in their Motions or Actions upon one another deſcribe, or what the Effects of theſe Motions and Actions are; and then to inveſtigate what Conditions of the *Univerſal Law* of Gravitation will make Bodies deſcribe theſe Lines, or produce theſe Effects. Thus if any of the *Primary* or *Secondary Planets* did deſcribe perfect Circles or *Ellipſes* about the *Sun*, or a *Primary Planet* plac'd in the Center, the Condition of the *Univerſal Law* in theſe would be, that the *attractive Force* at different Diſtances from the Center, would be as theſe Diſtances directly. If they deſcribed a *Parabola*, by ſuppoſing the *attractive Force* at an infinite Diſtance, or an *Hyperbola*, by changing the *Centripetal* into a *Centrifugal Force*; then the Condition of the *Univerſal Law* would be, that the Force were always *equable* and the ſame at all Diſtances in the firſt Caſe, and as the Diſtances *directly* in the ſecond, as Sir *Iſaac Newton* has demonſtrated, *Prop.* 11. *Lib.* I. We find, as has been inſinuated in the preceding Sections, That the Rays of *Light* in paſſing thro' different *Media*, are attracted *perpendicularly*, to either the Plane of *Incidence* or *Reflexion*; ſo that the Force of Attraction is always the ſame, at equal Diſtances from the ſame Plane. We ſee that the Parts of *Air* ſhun or fly from one another, inſtead of tending to one another; ſo that in accounting for the Appearances of Nature from the *Univerſal Law* of Gravitation, we are not ty'd to one ſingle Condition, but may have recourſe to others, as the Nature and Neceſſity of the Appearances ſeem to require; for the whole Difficulty of *Philoſophy* ſeems to lie in inveſtigating the Powers and Forces of Nature, from the Appearances of the Motions given, and then from theſe Powers to account for all the reſt.

§ XLII. The obvious Appearances of *cohering* Bodies are thus: Two very ſmooth, well-poliſhed plain Bodies, put together, will firmly cohere, even in an exhauſted Receiver; which ſhows evidently that their *Coheſion* is owing, neither to the Gravity, nor to any other Property of the Air; Saline Particles, when at a proper diſtance, and at freedom, will ſhoot and unite into Cluſters of themſelves: All ſaline, cryſtalline, and moſt mineral Bodies, break in very ſmooth and plain, or at leaſt *congruent* Surfaces; and univerſally almoſt all hard and very compact Bodies, break with Surfaces, which immediately upon the Separation, appear whitiſh, which is an Evidence, that tho' the Surfaces be very ſmall, yet they are very ſmooth and poliſh'd, for only innumerable little poliſh'd Surfaces are fit to reflect plentifully all kinds of Rays, whereby white Colours are produc'd. Now theſe Appearances of *cohering* Bodies, do naturally lead us to imagine, that one neceſſary Condition toward *Coheſion*, is the plainneſs, or at leaſt *Congruity* of *cohering* Surfaces, and this ſeems neceſſary to exclude any Fluid from lying between *cohering* Bodies; for theſe Bodies cannot be ſaid to *cohere*, or be continued, betwixt whoſe *cohering* Surfaces, in all their Points a Fluid may inſinuate it ſelf. The plainneſs and ſmoothneſs of the *cohering* Surfaces, will make more Points come into *Contact*, than when they are rough and irregular. For whatever Cauſe *Coheſion* ariſes from, if we ſuppoſe that Cauſe to act moſt ſtrongly at the *Contact*, the more Points of the *cohering* Bodies come into *Contact*, the firmer the *Cohesion* will be; and tho' exact Congruity in *Curve* Surfaces, will bring as many Points into *Contact* as plain Surfaces will, yet *Curvity* not being the ſimpleſt, nor moſt expeditious Method of producing this Effect, neither agreeable to Nature (who always brings about all her Effects the ſhorteſt and eaſieſt way) it ſeems evident, that the plainneſs and ſmoothneſs of Surfaces, is one Condition of *Coheſion*, and that thoſe *Atoms* that are terminated with plain Surfaces, will (*cæteris paribus*) produce Bodies of the firmeſt *Coheſion*. This will appear more evident from the contrary Quality in the conſtituent Particles of Fluids: For we have ſhown before, that one neceſſary Condition of *Fluidity*, is the *Curvity* of the Surfaces of the conſtituent Particles of Fluids, whereby their *Coheſion* is very ſmall, in reſpect of the *Coheſion* of thoſe Particles that are terminated with plain Surfaces, and their Gravity always exceeds the Force of their *Coheſion*, ſo that from both theſe Cauſes, they eaſily ſlip and move one upon another. We may then ſuppoſe, that ſome of the *Primary Atoms* of which Bodies are conſtituted, are terminated with plain Surfaces on all ſides, which will produce Bodies of the firmeſt *Coheſion*; others are partly terminated with plain, and partly with *curve* Surfaces, which will produce Bodies of a mean *Cohesion*; others again are intirely terminated with *curve* Surfaces, which will produce Fluids, and between thoſe intirely plain, and intirely *curve*, there are infinite *Combinations* of plain and *curve* Surfaces, which will account for all the various Degrees of *Cohesion* in Bodies, in reſpect of their Figures. But tho' this ſmoothneſs and plainneſs in the Surfaces of *cohering* Bodies, will bring moſt Points into *Contact*, yet this will not hinder them from being ſeparated by any Force, how ſmall ſoever; and ſince we are certain, that *cohering* Bodies require a determined Force to ſeparate them, there wants ſtill a *Cement*, as it were, to hinder them from being eaſily ſeparated when join'd. Now this can be deriv'd from nothing in Nature, but that *Univerſal Law* of Attraction, whereby all the Parts of Matter endeavour to *embrace* one another, and cannot be ſeparated but by a Force ſuperior to that by which they attract one another; let us then enquire what Condition of the *Univerſal Law* will moſt fitly anſwer the Appearances of *Cohesion*.

§ XLIII. On the Center *A*, and at the Diſtance *A D*, let a Circle be deſcrib'd, to whoſe Plane at *A*, let *P A* be *perpendicular*, and *P* be a *Particle* of Matter, attracted by all the Particles of this Circle, in any Condition of the *Univerſal Law*, from *P*, to any Point in the *Radius* of the Circle draw *P E*, in the right Line *P A*, take *P F* = *P E*, and at *F* draw *F K* parallel to *A D*, of ſuch a length as may repreſent the Force whereby the Particle *E* at-



tracts the Body *P*, and let *L K I* be the *Curve* which the Point *K* thus conſtantly circumſtantiated Generates: Sir *Iſaac Newton* has demonſtrated, *Pag.* 196. *Prop.* 90. *Lib.* I. *Princip. Phil. Mathemat.* 2*d Edit.* that the Force whereby the whole Circle, upon the *Radius A D*, at-

tracts

tracts the Corpuſcle *P*, is as the *AHIL* multiplied upon the Diſtance *AP*, let *PF* be called *x*, and *FK*, *y*; and let *FK*, or the Force whereby the Point *E* attracts the Body *P*, be reciprocally as any Power (ſuppoſe *n*) of *PF*, then the *Equation* of the *Curve* will be $y = \frac{1}{x^n} = x^{-n}$ whoſe *Area* $OPFKM = \frac{x^{1-n}}{1-n} = \frac{1}{1-n\,x^{n-1}}$. And if for *x* you ſubſtitute *PA*, you have the *Area* $OPALM = \frac{1}{1-n\;\overline{PA}|^{n-1}}$. If for *x* you ſubſtitute *PH*, then you have $OPHILM = \frac{1}{1-n\;\overline{PH}|^{n-1}}$, and therefore putting $m = n - 1$, we ſhall have $AHIL = OPHILM - OPALM = -\frac{1}{m} \times \frac{1}{\overline{PH}|^{n-1}} - \frac{1}{m} \times -\frac{1}{\overline{PA}|^{n-1}} = \frac{1}{m \times \overline{PA}|^{n-1}} - \frac{1}{m \times \overline{PH}|^{n-1}}$, and conſequently the *Attraction* of the Circle upon the *Corpuſcle* $= PA \times AHIL = \frac{PA}{m \times \overline{PA}|^{n-1}} - \frac{PA}{m \times \overline{PA}|^{-1}} = \frac{1}{m \times \overline{PA}|^{n-2}} - \frac{PA}{m \times \overline{PH}|^{n-1}}$.

If $n=1$. and $PA=0$, then the *Radius* of the attracting Circle being produc'd, wlll coincide with the *Aſymptote* PO, in which Caſe (the *Curve* being the vulgar *Hyperbola*, the *Area* $AHIL$ will be infinite, and PA being nothing, or the Diſtance between the *Corpuſcle* and the *attracting Plane* vaniſhing, the *Attraction* $PA \times AHIL = 0 \times \infty = 1$.

If $n=1$ and $PA=\infty$ *i. e.* when the *attracting Plane* AD, is plac'd at the *Concourſe* of the *Hyperbola*, with its *Aſymptote* PH, then the Arch DH (whoſe Center is P, and whoſe *Radius* is $PD=PA=\infty$.) will coincide with AD, and conſequently AL and HI will coincide, and therefore $PA \times AHIL = \infty \times 0 = 1$.

If $n=1$ and $PA=a$, let AH be called y, then $PH=x=a+y$. And the *Attraction* of the Circle upon the *Corpuſcle* $PA \times AHIL = y - \frac{y^2}{2a} + \frac{y^3}{3a^2} - \frac{y^4}{4a^3}$ *&c.*

If $n=2$. and $PA=0$, then the *Area* $AHIL$ will be *more than Infinite* (the meaning of which Expreſſion ſhall be afterwards explain'd) and therefore the Attraction will be $PA \times AHIL = 0$ multiply'd into more than Infinite; from whence it appears that the Force of the *Attraction* in this Caſe, when $PA=0$, is greater than that in the former Caſe, where $n=1$. and $PA=0$.

If $n = 2$ and $PA = \infty$, there the *Area* $AHIL$ will be nothing, and conſequently the *Attraction* $= PA \times AHIL = \infty \times = 1$. And hence it appears that in this Caſe, if $PA = o$, the *Attraction* will be greater than when $PA = \infty$. for of two Products, having the ſame Multiplicator, that is the greater, which has the greater Multiplicand, ſo that if A denote the *Attraction*, when $PA = o$ and a the *Attraction*, when $PA = \infty$, I ſay that A is to a, as a greater than infinite is to infinite, contrary to what happen'd in the firſt Caſe, where $n = 1$, for the *Attraction* in that Caſe was the ſame both when PA was equal to o and to ∞, *viz.* 1.

If $n = 2$ and $PA = a$, then as formerly AH being call'd y, the *Attraction* $= PA \times AHIL = \frac{y}{a} - \frac{y^2}{a^2} + \frac{y^3}{a^3} - \frac{y^4}{a^4} + \frac{y^5}{a^5}$, &c.

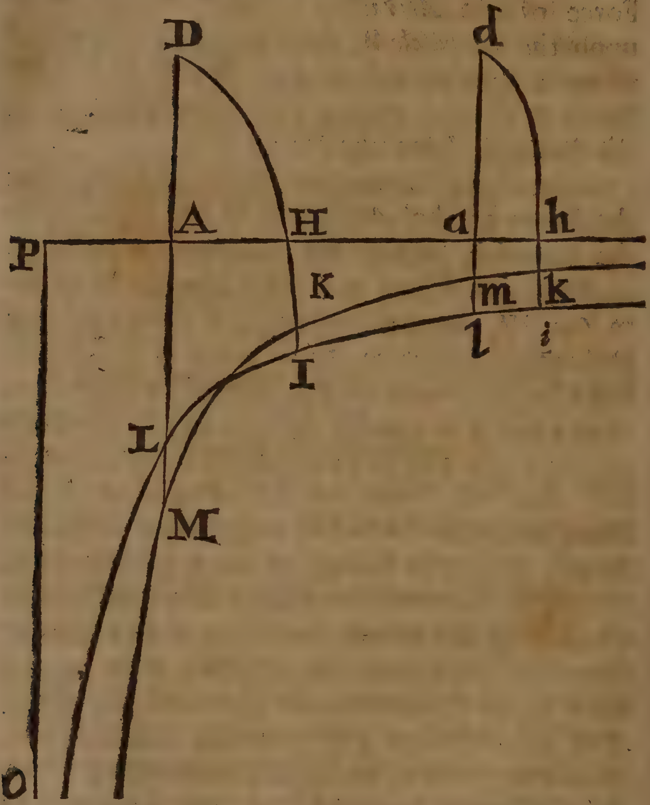
If $m = 3$ and $PA = o$, then $AHIL$ will be more than infinite, but $AHIL$ in this third Caſe will be greater than $AHIL$ in the ſecond Caſe, and conſequently the Force of the *Attraction* when $PA = o$ in both Caſes, will be greater in this Caſe than in the ſecond Caſe, for the reaſon now mentioned, *viz.* becauſe $PA = o$ is a common Multiplicator in both, and A H I L in this Caſe is greater than A H I L in the ſecond.

If $m = 3$ and P A $= \infty$, then as before, AHIL will be equal to nothing, and conſequently the *Attraction* will be $\infty \times o = 1$.

If $m = 3$ and P A $= a$, then the *Attraction* will be equal to $\frac{y}{aa} - \frac{3y^2}{2a^3} + \frac{2y^3}{a^4} - \frac{5y^4}{2a^5} + \frac{3y^5}{a^6} - \frac{21y^6}{6a^7}$, *&c.* After this manner, the Force of the *Attraction* of the *circular Plane* upon the *Corpuſcle* P, may be eaſily computed in an aſſignable caſe of the *Powers* of the Diſtance P E, and at any aſſignable Diſtance of the *Corpuſcle* from the Plane.

From theſe *Calculations* it is evident, that the Force of the *Attraction* of the Plane upon the *Corpuſcle*, when the Diſtance is nothing, or when the Plane and the *Corpuſcle* come into *Contact*, increaſes when the *Powers* of the Diſtance n increaſe; thus when $n = 2$, and P A $= o$, the Force of the *Attraction* is greater, than when $n = 1$ and P A $= o$, and ſo in others higher. As alſo it's clear from theſe *Calculations*, that the Force of the *Attraction* of the Plane upon the *Corpuſcle*, at the ſame finite Diſtances decreaſes faſter, or at a greater rate, when the *Powers* of the Diſtances are high, than when they are lower, or when n is a greater Number, than when it is leſs; thus at the ſame finite Diſtances, the Force of the *Attraction* is much leſs *proportionally*, when $n = 3$, than when $n = 1$, or 2, and ſo in others where the Difference between n in one Caſe and in the other, is yet greater.

Laſtly, Suppoſe the attracted Particle *P* and *P A H a h* and *P O* to be the *Aſymptotes* of the *Hyperbola,* whoſe Ordinates are proportional to the *Attraction* of a Particle at their reſpective Diſtances from *P*, then if the *Attraction* be reciprocally as the Diſtances, having deſcrib'd the common *Hyperbola* *i l I L*, whoſe Ordinates



nates AL are equal to $\frac{1}{PA}$ the *Attraction* of a Circle whoſe Radius is AD, will be as the *Hyperbolical* Space $AHIL \times PA$, the Line PH being made equal to PD, and when the Circle is plac'd at an Infinite Diſtance Pa, the *Attraction* will be $ahil \times PA$. But in this Caſe $ah = \frac{adq}{2Pa} = 0$, wherefore $ahil = al \times ah = \frac{1}{PA} \times ah$, and the *Attraction* is ah, that is 0, or infinitely leſs than at any finite Diſtance. Likewiſe when PA is infinitely little, the Space $AHIL$ is infinitely leſs than $AH \times AL$, *i. e.* than $\frac{AH}{PA}$; ſo that the *Attraction* which is as $AHIL \times PA$ will be infinitely leſs than AH, that is, at Contact it will be 0, this *Attraction* is biggeſt when $AHIL = \frac{ADq.}{PDq}$

Again, Let $kmKM$ be a Curve whoſe Ordinates AM are equal to $\frac{1}{PAq}$, then the *Attraction* of a Particle being *reciprocally* as the Squares of the Diſtances the Force of the Circle plac'd in A will be as $AHKM \times PA$: So that comparing theſe two kinds of *Attractions* together, the *Radius* of the Circle AD being given, and the Diſtance PA the ſame in both Caſes, they will be as the Spaces $AHIL$ and

AHKM, which when the Diſtance is infinite is, as the Ordinates *hi* and *hk*, *i. e.* as $\frac{1}{Pa}$ and $\frac{1}{Paq}$, or as *Pa* to 1, that is, as infinite to finite. And when the Diſtance as 0, it is as 0 to 1. In the ſame manner, if the *Attraction* be reciprocally as the *Cubes* of the Diſtances, at the Contact the Force will be infinitely greater, than when the *Attraction* decreaſes as the *Squares*. If it decreaſes in a *Quadruplicat* proportion of the Diſtances, the Force at Contact will be infinitely greater, than when it decreaſes as the *Cubes*, and ſo on. So that if n be taken ſucceſſively, as 1, 2, 3, 4, *&c.* the correſponding Forces at Contact will be as $0. 1. \infty : \infty^2$, *&c.* And if we ſhould compare the ſame Forces at an infinite Diſtance, they would be $0. 0^2. 0^3. 0^4.$ *&c.*

Now to apply this to the *Coheſion* of Bodies: It's certain that the firſt Condition (*viz.* when the *Attraction* is reciprocally as the Diſtance between the *attracting* Bodies) cannot obtain in the *Coheſion* of Bodies; for the Difference between the Force, when the Bodies are in *Contact*, and when they are at ſome Diſtance from one another, in this caſe is ſo ſmall, as does not anſwer the *Appearances*: for we find, that the Force whereby Bodies *cohere*, is very much greater, when they come to immediate

Contact, than when they are at ever ſo ſmall a finite Diſtance from one another.

In the ſecond Condition of the *Univerſal Law* of *Gravitation*, (*viz.* when the Force is *reciprocally* as the *Squares* of the Diſtance,) the Difference of the Force of *Coheſion*, between Bodies at immediate *Contact*, and of the ſame, at ſome Diſtance from one another, is greater than in the former Caſe; but not ſufficient to account for this Difference obſervable in the manner of the *Coheſion* of Bodies. But if it were poſſible to gather by *Experiment*, the *proportion* of the decreaſe of this Force, in *cohering* Bodies, to the ſame, at ſome determin'd Diſtances from one another, that would give the Condition of the *Univerſal Law*. But it will be very difficult to make any ſuch *Experiments*, becauſe the Fluids which ſurround Bodies, upon the Surface of our *Globe*, get in between the Surfaces of Bodies when they are at any Diſtance, greater than the *Diameters* of the conſtituent Particles of theſe Fluids, and ſo by their lateral preſſures, deſtroy the efficacy of the Force whereby Bodies *cohere*; thus the Particles of *Light*, and of *Air*, get in between the Surfaces of Bodies, remov'd at almoſt an inſenſible Diſtance from one another, and ſeeing *Light* and Bodies act mutually upon one another, and that the Particles of *Air*, endeavour to recede from one another, they render the efficacy of the Force of *Attraction* whereby Bodies *cohere*, altogether inſenſible at any Diſtances from one another, greater than are the *Diameters* of the Particles of theſe Fluids; and a Diſtance equal to the *Diameters* of ſuch ſubtil Fluids, is too ſmall to be diſtinguiſh'd by our Senſes, howſoever aſſiſted. After all, it ſeems pretty difficult, to conceive all the Varieties of *Coheſion* in Bodies, from that one Principle of *Attraction*, and the plainneſs of Congruity of Surfaces. For there is no one Law of *Gravitation* comprehended in $-\frac{1}{x^n}$ $(=y)$ which will beget a Curve $IKLM$, that will anſwer both theſe Conditions, $0 \times AHIL =$ to ſomething, and $PA \times AHIL =$ to nothing; which it ſeems it muſt do to explain *Coheſion*. Beſides, it would agree much better with the ſimplicity of Nature, if the general Law where $n = 2$, which obtains in the Celeſtial Bodies, cou'd be made agree with the Appearances of *Coheſion*. It is not impoſſible, that the Attraction, which at contact in this laſt mentioned Caſe, is 1 or finite, at any Diſtance whatſoever that Human Experiments can determine or obſerve, may be ſo intirely deſtroyed by the Interpoſition of foreign Fluids (that are not ſubjected to any of our Experiments in exhauſting, ſuch as is Light, and perhaps a yet more ſubtile Fluid. *Vid. pag. ultim. 2d Edit. Princip. Newtoni*) acting in a contrary Direction, as to leave no remaining Force in it: Or perhaps the Figures of the conſtituent Particles of Bodies are to be conſidered in the Affair of *Coheſion*, as well as the Law of *Attraction*, to give a ſatisfying Account of it.

§ XLIV. *Coheſion* in general, being ſuppos'd after ſome ſuch manner as has been explain'd, it is no hard matter to underſtand *Elaſticity*, which ſeems to ariſe from the ſame *Principles*, of ſmooth and plain Surfaces, and of ſome one or more of the mention'd Conditions of the *General Law of Attraction*. In bending *elaſtick* Bodies, we find the *Convex* ſide exceedingly ſtretch'd, inſomuch, that by frequent and long continued Bendings, there become viſible *Fiſſures* in the out-ſide, which no doubt were there before, or in the firſt Bendings, tho' not ſo large, as to be viſible, as alſo we ſee the *Concave* ſide, mightily contracted, or its Parts forcibly preſs'd together, ſo as to run into Folds or leſſer *Convexities*, on the in-ſide: the ſame thing happens, when two *elaſtick* Globes or Balls, ſtrike againſt one another, only the *Convex* ſides, are turn'd in towards their *Centers*; the Matter being thus, let us ſuppoſe, that two very ſmooth and plain ſquare Surfaces, are join'd together, ſo that each Particle in theſe Planes, attracts another, by ſome one or other of the Conditions of the *General Law of Attraction* ; if theſe Planes, by any external Force, were ſo ſeparated, as to move upon a common ſide of the Congruent ſquares as an *Axis*, and that no foreign Fluid endow'd with a disjoyning Force (ſuch as *Air* and *Light* are) cou'd interpoſe to hinder their Action: it is certain, rhat the external Force which thus ſeparated theſe Planes, ceaſing to act, the *Attractive* Force wou'd immediately bring theſe Planes together again; and if theſe Planes were ſeparated by a *parallel* Motion, if the Diſtance were ſo ſmall, that no foreign Fluid could get in to hinder their Action, if the *ſeparating* Force ceas'd, the *attracting* Force would act and bring 'em together again; and in both Caſes, with a Force which may be eaſily gathered from the Condition of the Law of *Attraction*, and the Diſtance of theſe Planes being given. Now all *Elaſtick* Bodies in their Actions upon one another, changing their Figures, muſt of neceſſity have ſome of their Parts in theſe Actions, ſeparated by a *Parallel* or a circular Motion about an *Axis*; or by a Motion after ſome manner compounded of both theſe, (for it is no matter after what manner they are disjoin'd, provided they be not ſeparated ſo far, as to admit any foreign Fluid to enter, which may deſtroy the efficacy of the Force, whereby theſe Particles *attract* one another) If we then ſuppoſe the Surfaces of the Parts of *Elaſtick* Bodies, plain and ſmooth, and that they *attract* one another after ſome one or other Condition of the *Univerſal Law*; being ſeparated by a foreign Force, they muſt (when that Force

ceaſes)

ſes) join together again with a certain degree of Force (which is to be eſtimated from the Diſtance and Condition of the *Univerſal Law* being given) and ſo will produce all the *Appearances* of *Elaſtick* Bodies.

It may be objected, that it does not appear from this Account of *Elaſticity*, how a Spring ſhould grow ſtronger the more it is bent, ſince in that caſe, the *Fiſſures* being made wider, the attractive Force ought to be leſſen'd, and conſequently the Power of *Reſtitution* ought to be ſo too. All I can ſay to this is, that there is a proper arrangement of the Parts to be brought about in *Elaſtick* Bodies, which may in ſome meaſure be more readily obtain'd or facilitated by uſe; as we ſee Watches go more regularly, ſmoothly and exactly after they have been us'd for ſome time; and it is pretty certain, that *Elaſtick* Bodies, upon this account, may run more readily into their Actions, when the Parts by uſe are form'd and fix'd in the Situation moſt proper for this purpoſe, which at firſt they may not ſo perfectly be, by reaſon of the ſolidity and firmneſs of the Parts of moſt *Elaſtick* Bodies: To confirm this, we ſee Springs by too long uſage, when the Parts are too much worn out, and the Chaps and Fiſſures become too large and viſible, decay and loſe their Power of *Reſtitution*, like other Organical Bodies, which Time and too long uſe wear out and render uſeleſs for their intended purpoſes. But perhaps the Appearances of *Co-*

heſion may be more congruouſly accounted for, from a proper Conformation of Parts, and the Action of an *Elaſtick* Fluid, which owes its Nature to the *Centrifugal* Force of its Parts: But this I am not at leiſure to explain in the Particulars. Upon ſuch *Principles* may the *Elaſticity* of *Tendinous* Bodies be explain'd, but it is not my Buſineſs here to deſcend into all the particular Circumſtances. If *Elaſtick* Bodies obſerv'd one conſtant *Proportion* in their unbending, toward their bending Forces, it were eaſie from thence, to determin the Condition of the *Univerſal Law* by which their Particles attract one another; but perhaps ſome may think, there are as great Varieties in this as in *Coheſion*; I ſhall not therefore trouble the Reader, in this place, with the particular Conſequences, from particular Conditions of the *General Law* of *Attraction*, but ſhall content my ſelf to have laid down *Principles* upon which theſe intricate *Appearances* may be, in ſome probable manner, accounted for.

I would proceed to ſome of the reſt of the *Appearances* of Nature, which might be accounted for from the ſame *Principles*, but that theſe already explain'd are moſt of what I ſhall make uſe of in the following Treatiſe, for which this *Chapter* was deſign'd only as a *Lemma:* Beſides, that ſome of the reſt will naturally come into the Subject of theſe other Diſcourſes.

CHAP.

CHAP. III.

Of the Origin of the preſent State of Things, and of the Epicurean *and Mechanical Hypotheſis.*

§ I. IT is a little ſurpriſing to ſee Men frequently contending and wrangling about the *Origin* of their ſeveral Families, and yet ſcarce any Body give Himſelf the trouble once ſeriouſly to conſider or enquire how the whole Race at firſt became to *be*, whether it ſprang from the *Earth* or dropt from the *Clouds*, when it began, or if ever there was a time when it was not; tho' theſe Enquiries be far more worthy a wiſe Man's pains than thoſe inſignificant Conteſts. We are eaſily ſatisfy'd we and our immediate Parents have not been for ever; but few of us go farther, we take this World as we find it, without troubling our Heads *who made it*, or whether it was *made* or not. No Body can well bear to have their *Anceſtors* affronted, nor their *Pedigree* deſpiſed; and yet very many now a days don't ſcruple to own themſelves the *Children* of the *Earth*, or the Offspring of *blind Fate and Chance*. Whatever others may do, I ſhall not think my Pains ill beſtow'd once in my Life to have examin'd min'd, as far as my poor Abilities will carry Me, how this preſent ſtate of things became at firſt to *be*.

§ II. There are three general Opinions about this matter, the firſt is of thoſe of the *Epicurean* Sect, that holds that an *immenſe Void*, and an Infinity of differently figur'd, very ſmall, extreamly hard and infrangible *Particles of Matter* have for *ever been*; and that theſe Particles moving of 'emſelves in a direction oblique to one another, after innumerable *rencounters*, did at laſt ſettle in this *beautiful order of things* we now behold. This is a *Scheme* upon which ſome build their *Hopes*, and upon the account of which ſome of our *Moderns* think 'emſelves ſubtil *Philoſophers*, how juſtly we ſhall now examine.

§ III. Firſt this *Scheme* ſuppoſes Matter to have for ever been of it ſelf, without any Cauſe; which is a very liberal Compliment to ſuch an unactive inanimate Maſs, to make it independent for its Being anduncapable of being deſtroyed (both which *Self-exiſtence* neceſſarily implies) *that is* to make it neceſſary, *that is* to make it infinite and eternal, and to raiſe it to a very high pitch of Dignity, to which we find none of its other qualities anſwerable. *Time and Space* or ſomething *Analogous* to what we call by thoſe names, it's true may have for ever been; but that is becauſe they may have ſome relation to a Being endow'd with all other ſuitable qualities; but Matter ſeems to be too ignoble a Being to arrogate ſuch high *Endowments.* But paſs we over this Head at preſent, as not eſſential to the Buſineſs in Hand. And,

§ IV. Let us conſider how out of theſe few *Principles* of an *immenſe Void,* an infinity of very ſmall, hard and infrangible *Particles,* and their *oblique Direction* to one another, it is poſſible to form this preſent State of things. We have prov'd, § XI. of the preceding *Chapter,* that *Motion* is no more *eſſential* to Matter than Reſt; that of it ſelf it can never bring it ſelf into Motion; that it would for ever continue in the State it is put in, and, if it was from all Eternity at Reſt, it would continue ſo for ever; if in Motion, it would for ever move on. Now this being the Caſe, it would have been a great advantage to their Opinion, could they have ſhown whence this Motion did at firſt proceed; ſince it is ſuppos'd there is nothing beſide unactive Matter it ſelf to produce it. Whatever can be ſuppos'd to put Matter in Motion, may at the ſame time, and with the ſame eaſe, be ſuppos'd to have directed the ſeveral Parts thereof to the Places they are now in, *i. e.* to have produc'd this *preſent State of things.* No Body can think Motion *eſſential* to Matter, who ſees any Part thereof at reſt; for what is *eſſential* to any thing, that thing can never be without it. But ſome *Philoſophers,* and thoſe of great Name too, have aſſerted, that no part of Matter ever was nor can be at abſolute reſt. For, ſay they, Motion is a Quantity, and may be divided *in infinitum* as well as other Quantities, and a Body may be moving any finite time, and yet never ſenſibly change its *relative* Place; for the Space is as the Velocity, and if the Velocity be very ſmall, the Space it moves through is ſo likewiſe: And they alledge, that thoſe Bodies which ſeem to be at reſt, are only alternately moving very ſlowly to and from the *termination* of the Motion, or the *Obſtacle*. To this I anſwer, that tho' it may be very true, that nothing in this Univerſe is actually at *abſolute reſt*, but that every thing is in ſome degree of Motion; yet that abſolute Reſt in Bodies is not impoſſible, is clear from hence, that it implies no Contradiction; A Sphere in a Vacuity ſhould be preſs'd by two other equal Spheres, with equal Forces and contrary Directions, from which preſſure the intermediate Sphere would be at *abſolute reſt*; wherefore, if it is not abſurd a Body ſhould be at *abſolute reſt*, it is impoſſible Motion ſhould be *eſſential* to Matter. There is another Argument, which to me ſeems very concluſive againſt Motion's being *eſſential* to Matter, and that is, from the infinite poſſible Varieties of its Directions; laying aſide the conſideration of all other Bodies, or ſuppoſing a Body moving *in vacuo*, it muſt move in one certain *Direction*. Now what is it that determines it to this *Direction* rather than to any other of the infinite Variety? no Reaſon can poſſibly be aſſign'd, why it ſhould move rather in this than in any other of the infinite number of Directions. And it cannot poſſibly move in more than one of 'em at once, and therefore it will of it ſelf move in none of 'em, *i. e.* it will not of it ſelf move at all, and conſequently, Motion is not *eſſential* to Matter. For in the Faculties of natural things, which are not endow'd with Free-will, where there is an infinite variety of Choice, and no poſſible Reaſon to determin any one way, there can be no Choice made at all. From all which it is plain, that allowing the *Abettors* of this *Philoſophy* their *Void* and their *Atoms*, yet nothing cou'd be produc'd for want of Motion, it not being *eſſential* to Matter, as has been prov'd, and there being nothing elſe to produce it.

§ V. But allowing Matter to be *ſelf-exiſtent* and *ſelf-moving*, I would know whence came this *obliquity* of *Direction*, which they *gratuitouſly tack* to Matter; this is to aſcribe Will and Choice to theſe Particles, and to alledge, that they are capable of reſolving what way they will go. The Contrivers of this *Scheme* ſaw wiſely enough, that granting theſe *Atoms* to be *ſelf-moving*, yet nothing would follow but an eternal wandering in Lines *parallel* to one another, without any other effect; and therefore they added, that theſe Particles mov'd with different *oblique Directions* to one another, by which means they would meet, and juſtle, and reflect, innumerable different ways. But does not every Body ſee, that it is as eaſie and as intelligible to ſuppoſe this World already in Being, as to ſuppoſe theſe Particles endow'd with this *obliquely* directed Motion, the Cauſe of the one being no leſs accountable from their Principles than the other. We ſee all Motions now perform'd in the ſame Direction with that of the moving Force, and all Motions produced by the ſame *adequate Cauſe* have the ſame *Directions*; and conſequently, if the Motion of theſe Atoms ariſes from themſelves, they muſt all follow the ſame *Directions*, *i. e.* they muſt all move in *parallel* Lines; and conſequently, they could never meet in order to produce any regular Effect. It is ſurprizing we ſhould not find that Matter or Bodies now can alter their Directions, and yet, according to the Opinion of theſe Men infinite Ages by-paſt, they have mov'd as they liſted. Why do they not ſo ſtill? Since (according to their own Suppoſition) nothing has happen'd to alter their Nature, or the manner of their Motions ever ſince; it is altogether unaccountable why Matter ſhould move in one *Direction* rather than another, upon any other account but the *Direction* of the impreſs'd Force; and all that's alledg'd on this Head by the *Favourers* of this *Scheme* is altogether *precarious* and *abſurd.*

§ VI. But

§ VI. But allowing theſe *Atoms* to be *ſelf-exiſtent*, *ſelf-moving*, and *obliquely* directed, yet 'tis ſtill inconceivable how they ſhould produce a World. For theſe *Atoms* could not move all with the ſame degree of Obliquity to one another, for that would be making 'em all *converge* to a Point, and ſo nothing but one great ſolid Sphere could be produc'd, if they happen'd to unite after their meeting: And if they again reflected from one another, they would produce a fluid Sphere, their rectilinear Motions turning into circular ones, or otherwiſe would wander on in right Lines as before. And to make ſome converge to one Point, others to another, is to ſay, theſe Atoms were intelligent free Beings, which could chuſe the Courſe they would go in. We have a very powerful Proof of the inſufficiency of theſe *Atoms*, tho' endow'd with their *obliquity* of *Direction* to produce any thing, in the Rays of the Sun; which, as was before prov'd, are very ſmall Parts of Matter, by the interpoſition of the Surfaces of reflecting Bodies differently ſituated, obtaining all poſſible varieties of Obliquity; and yet theſe produce no regular *Syſtems* of Bodies, tho' they move and probably juſtle and interfere all imaginable ways. As I have juſt now ſaid, thoſe only whoſe *Directions* converge to a Point, could meet to produce any real Body, and even the Body which would be produc'd would only be a *ſphe-*

rical one. So that out of all their Motions, only *Spheres* of different Magnitudes could be form'd, which how ſmall a part this is of the infinite variety of Bodies in this Univerſe, I leave the Reader to conſider. The Truth of the matter is, if Bodies were *ſelf-moving*, they could move what way they pleas'd, and ſtop when and where they pleas'd, *i. e.* they would be free-will'd *Elective* Agents.

§ VII. Again, allowing theſe *Atoms* to be *ſelf-exiſtent*, *ſelf-moving*, and *obliquely* directed, yet I would gladly know, how from thence this *Univerſe* could be fram'd. It is not enough to ſay barely theſe *Atoms*, thus diſpos'd, would at laſt ſettle into this State of things, unleſs it be ſhewn by what particular *Motions*, *Directions* and *Reflections*, the principal Bodies of this Univerſe were fram'd. To ſhew a thing poſſible to be done, we muſt tell how, what way, and by what Laws it may be done. For unleſs we deſcend to Particulars, we are never certain it can be ſo; and 'tis as probable (till the contrary be evinc'd, in ſome Particulars at leaſt) it may not be ſo. *Generals* are always to be ſuſpected; a Contradiction may be diſcovered in the particular Explications of an Appearance that was not taken notice of in the *general Scheme*; as indeed it happens in every individual Inſtance of this preſent Subject hitherto attempted. I ſhall not ask of thoſe who defend this *Scheme*, a particular account of the *Mechaniſm* of every individual Appearance in our *Syſtem*, for that indeed were endleſs: But if any one can tell by what Laws of Mechaniſm, any one Animal or Vegetable was produc'd, or from what mechanick Principles the Planets deſcribe *Elliptick* Orbits, I ſhall for the ſake of theſe allow their whole *Scheme* to be true. We all know how wretchedly *Des Cartes* (the ableſt *Patron* that ever this Opinion had) has blunder'd on theſe Heads, and his Followers have not mended the matter much. It is ſurpriſing to think how any reaſonable Man could believe this *Univerſe* to have been produc'd by Matter and Motion, when as yet no Man that ever liv'd, from theſe Principles alone, can tell by what *Mechaniſm* the moſt contemptible of the *Celeſtial* or *Terreſtrial* Bodies could be produc'd; and yet to be fully ſatisfy'd of the Truth of this *Hypotheſis*, a Man muſt underſtand the particular Mechaniſm of the whole *Syſtem* of Things, and of every individual Appearance.

§ VII. Theſe *Atoms* are ſuppos'd *infrangible*, extremely compacted and hard (as indeed the leaſt Parts of Matter muſt neceſſarily be) which *compactedneſs* and *hardneſs* is a demonſtration, that nothing could be produc'd by 'em, ſince being ſo, they could never come to cohere, in order to produce ſolid Bodies. The only tolerable account of *Coheſion* in ſuch like Particles, is from their branch'd Figure. Now hard ſolid Particles reflecting from one another, can never poſſibly lay hold of one another, at leaſt not ſo but that the leaſt Motion will disjoin 'em again. It is impoſſible to conceive, how innumerable hard and compacted *Atoms*, ſwimming in an immenſe *Abyſs*, could ever come to cohere, ſo as to produce ſuch hard Bodies as *Diamonds*, and ſome other *Mineral Subſtances* are, without any other cement but their catching hold of one another; this mutual embracing might keep 'em from being eaſily torn aſunder, but they would be ſtill moveable like chain'd Work, and could never produce the appearance of Firmneſs and Solidity. And what is here ſaid of Coheſion and Solidity, may be likewiſe ſhewn of Elaſticity. And thus allowing theſe *Atoms* to be *ſelf-exiſtent*, *ſelf-moving*, and *obliquely* directed, and to meet according to any Laws of *Mechaniſm*, yet they could only produce looſe heaps of *Atoms*, or ſuch moveable ones that are altogether unlike the ſolid Bodies we now behold. So that to account for the production of this preſent State of things, beſides their Matter and Motion, the *Abettors* of this Opinion want a Principle for Solidity, or Coheſion and Elaſticity; both which are owing to no eſſential Property of Matter, as is ſhown in the two laſt *Sections* of the preceding *Chapter*.

§ VIII. There are ſeveral *Appearances* abſolutely unaccountable from the Laws of *Mechaniſm*, and conſequently, theſe could never be produc'd by Matter and Motion alone, or any *Combinations* of 'em. It were endleſs to alledge all the Inſtances that might be brought on this Head; ſome few of the moſt conſiderable will ſuffice; for if any one be inconſiſtent with the Laws of *Mechaniſm*, then it is impoſſible this *Syſtem* could have been produc'd by the concourſe of *Atoms*. The firſt I ſhall inſtance in, is that great Law to which all the Bodies of this Univerſe ſeem to be ſubject, *viz*. That of *Gravitation*. In the former *Chapter* I have endeavour'd to ſhew, that this Property is not *eſſential* to Matter, nor can ariſe from the Figure, Texture or Motions of its Parts, but is *implanted* therein by ſome Power ſuperior to that of Matter; whence it is evident, that one of the primary Attributes of Matter is independent of the Laws of *Mechaniſm*. That active Principle which animates, as it were, the dead Maſs of Bodies, and which is the Cauſe of all the beautiful *Appearances* of Nature, owes its Origin to ſomething different from Matter and Motion, and therefore this *Syſtem* of things could not ariſe from thence.

§ IX. Not only *Gravitation*, or that implanted Principle whereby Bodies tend towards one another, is above the Powers of Matter, but all the Effects and Appearances that neceſſarily depend thereupon, *i. e.* all the *Celeſtial* and *Terreſtrial Appearances* are likewiſe above the Powers and Laws of Matter and Motion. All the Attempts of others before Sir *Iſaac Newton*, to explain the regular and conſtant *Appearances* of Nature, were moſt of 'em *Ungeometrical*, and all of 'em ſo inconſiſtent and unintelligible, that it was as hard to allow their *Poſtulata*, as to conceive the thing which they pretended to account for from them. All the *Philoſophers* that ever were, could never from the meer Laws of *Mechaniſm*, explain how the Planets came to move in *Elliptick* Orbits, they might (if Matter had been ſelf-moving) have for ever ſtray'd in right Lines; but, that they ſhould conſtantly revolve in Orbits, that they ſhould approach to and remove from a determin'd Point at different Seaſons, and that uniformly and conſtantly, is altogether unaccountable from the Laws of *Mechaniſm*, as has been ſhewn in the former *Chapter*. But from this implanted Principle of *Gravitation* (ſuppoſing they are already put in their Motions, and that all the *Celeſtial Machinery* is now actually in motion and at work) all the *Phænomena* are accounted for, and that to the greateſt nicety we are capable of diſtinguiſhing. So that not only this Univerſe could not have been produc'd by the Laws of *Mechaniſm*, but there is ſcarce a ſingle *Appearance* that can thence adequately be accounted for.

I have already diſtinguiſhed between the *Laws of Creation,* and that of *Nature*: The firſt are the Laws obſerv'd by the *Univerſal Syſtem of Things,* whilſt it was in *Fieri* (as the Schools ſpeak); the latter the Laws of the Actions of Bodies, when it (the Syſtem of Things) is in *Facto eſſe.* The firſt are quite different from the latter; for tho' Matter and Motion might help us to explain ſome ſmall part of the Appearances, now Things are actually conſtituted; tho' even this be falſe, yet theſe, with all the Laws of Nature, and throwing in *Gravitation ex abundanti,* will never help us to explain one ſingle Appearance of Creation, Original Production, or the Primitive Formation, Adjuſtment and Arrangement of the greater or ſmaller integral Parts of this *Syſtem of things.* Can any one tell from theſe Principles, how the Figures of the Bodies of *Sun, Planets* and *Satellits* were rounded into their particular *ſpheroidical Orbs*? How the Kinds and Poſitions of their *Orbits* were determin'd? Whence their Number, Magnitudes and Denſity came? They may continue their Motion in empty Spaces, and deſcribe their determin'd *Orbits* by the Laws of *Gravitation* and Nature, but by theſe they could never have acquir'd their preſent regular Form and Situation. The ſix principal *Planets* revolve in Circles *Concentrick* with the *Sun,* in the ſame Direction of their Motion, and in the ſame Plane nearly:

The ten *Moons* or *Satellits* revolve about the *Earth*, *Jupiter* and *Saturn*, in *Concentrick* Circles, and the ſame Direction of their Motions, in the Planes of the *Orbits* of their *Planets* nearly. But theſe regular and comely Motions could not ariſe from *Mechanical* Cauſes, for the *Comets* move in *Orbits* extremely *Eccentrical*, and in all the Points of the Compaſs, which it is impoſſible they ſhould do, did they revolve by the ſame *Mechanical* Cauſes, by which the *Planets* move: it is abſolutely impoſſible once to imagine, the Parts of Light, and the other Fluids of our *Syſtem*, ſhould have been form'd by the Laws of *Mechaniſm*. In a word, one ſingle *Atom* of Matter, in its original Production and internal Conſtitution, is not to be explain'd from theſe Principles; and if the wiſeſt Philoſopher now being, will give a ſatisfactory account of any one Portion of the whole *Syſtem* of Creatures, from theſe Principles, as to its original Production and internal Conſtitution, I will, for the ſake of this, give up the whole Cauſe; and yet to ſatisfie himſelf, he ought to account for the whole from them.

§ X. The Production of Animals is altogether inconſiſtent with the Laws of *Mechaniſm*. 1. The Blood is ſqueez'd by the Force of the Heart from the left *Ventricle*, through the Arteries unto the Extremities of the Body, and is thence return'd by the Veins into the right

Ventricle; thence by the *Arteria Pulmonalis* unto the *Lungs*, from the *Lungs* by the *Vena Pulmonalis* to the right *Ventricle* again. The Motion of the Heart is caus'd by the nervous Fluids, acting ſome how upon or with the Blood in the *Muſcular* part thereof. And theſe nervous Fluids ſeem to be both deriv'd from the Blood, and forc'd into the *Muſcular* part of the Heart, by the Motion of the Heart it ſelf, the Texture of their containing Veſſels, and perhaps by the Pulſation of the Arteries upon the Nerves in the Brain. Here now the Heart is the Cauſe of the Motion of the Blood in the Arteries, and the Motion of the Blood in the *Arteries* urging their Juices through the Nerves, is the Cauſe of the Motion of the Heart, which is a plain *Circulation* of *Mechanical* Power, *i. e.* a *Perpetuum Mobile*; which by what was ſaid in the preceeding *Chapter*, is contrary to the Laws of *Mechaniſm*. If an *Epicurean Philoſopher* could contrive a *Water Machin*, that the *Water* ſhould move the *Machin*, and the *Machin* the *Water*, ſo that the ſame *Water* ſhould conſtantly return in a Circle to move the *Machin*; I ſhould then think their *Scheme* ſomewhat feaſible: But ſince the firſt is demonſtrably impoſſible, the latter muſt be ſo likewiſe. 2. In all Animals there are *Organs* in number actually indefinite, if not infinite. By an *Organ* I mean a diſtinct independent part of a *Machin*: Thus a Wheel, and all its

Parts, is an *Organ* of a Watch, if I may ſpeak ſo; and a *Gland* with all its parts, or a Canal from its Origin to its Extremity, is an *Organ* in an Animal Body. Now theſe Organs, or independent Parts in the Animal, are infinitely many, as is evident both from the Nature of *Senſation* and *Nutrition*. *Senſation* is perform'd by the mediation of an *Organ* ariſing from the Brain, and continu'd through the Part affected. Now there is not the leaſt imaginable ſolid part of the Veſſels or Muſcles but is ſenſible, and therefore the Organs in Animals that convey this Senſation, are infinite in number. To this perhaps it may be objected, that one *Organ* may convey *Senſation* thro' ſeveral places; and conſequently, tho' every minute part of the Body be ſenſible, it will not follow, that the Organs which convey this *Senſation* are infinitely many, ſince they may all be only the continuation of ſome few Organs through different Parts. But the Anſwer is obvious, if every Point of the Veſſels and Muſcles of the Animal Body be ſenſible, then the *Organs* which convey the *Senſation* are infinitely ſmall, and if infinitely ſmall they muſt be infinitely many, ſeeing their Extremities in the Brain conſtitute a finite *Superficies*, or fill a finite Space; for a finite Number of infinitely ſmall Parts, can never make a finite Quantity. Again, *Nutrition* is perform'd by an Organ, through which the Supply is convey'd to the Place to be nouriſh'd; and ſince there is no part of the Body that may not be increas'd or diminiſh'd (as is evident from the Cure of Wounds in all Places through which the neceſſary part of the Fluids of the Body can paſs) it is plain, that every individual point of the Animal Body is the Termination of an *Organ*, through which the *Nutrition* may be convey'd. Moreover, ſeeing even the Canals themſelves do increaſe in bulk, may decay and be impair'd, every aſſignable Part of theſe Canals muſt be the Termination of ſome *ſecretory* Duct, ſeparating a Fluid fit to increaſe their Dimenſions or repair their Loſſes; and theſe ſecretory Chanels again, muſt have others to increaſe *their* Bulk or repair *their* Loſſes, and ſo on *in infinitum*. Add to all theſe, that the fineſt Glaſſes diſcover nothing in the ſeveral parts of the Veſſels and Muſcles but fine ſlender Canals, and the better the *Microſcopes* are, the greater Number of thoſe capillary Pipes are diſcover'd; and theſe Parts, which were formerly reckon'd *Parenchymatons*, are now found to be bundles or heaps of exceedingly ſmall Tubes or Threads. The Muſcles themſelves conſiſt of a number of Fibres, and each Fibre of an incredible number of little *Fibrils*, bound together and divided into *little Cells* or *Veſicles*: The *Glands* are nothing but a *clew* of *little ſlender Pipes*, diverſly roll'd or folded together: The *Brain* is a numberleſs *Congeries* of infinitely ſmall Tubes, woven into ſeveral Figures: The *Nerves* are bundles of ſmall *cylindrical* Pipes; and the *Lungs* and *Liver* are but Heaps of little Bladders, upon which the Blood-Veſſels are ſpread in Net-Work, or of little Glands among which theſe Veſſels are diſpers'd. In one word, all the ſolid Parts of the Body are nothing, but either very fine exceeding ſmall Tubes for the conveyance of ſome Fluid, or ſlender Threads in Bundles ty'd together by others ſurrounding 'em, or going from one Fibre to another, or ſpread out into thin Membranes: For the *Bones* are nothing but ſuch Bundles, and all the Membranes or Membranous Coats of the Veſſels, are nothing but theſe Threads wrought together into thin Skins. From all which it is beyond diſpute, That every Animal is made of Organs in Number really infinite. For theſe Organs become at laſt infinitely ſmall, and ſo their Sum muſt be infinitely many, ſeeing it conſtitutes a finite Quantity. Now how ridiculous is it to imagine a Thing ſo wonderfully made could be the Effect of meer Chance, or of the blind Laws of Motion. In *Artificial Machines*, the more complicated and compounded the Contrivance of the Parts is, the greater the difficulty is in adjuſting them; and the difficulty increaſes in the ſame proportion the *Complications* do, and conſequently, when the *Complications* are infinite, the Machin is altogether above the Power of *Mechanicks*, and quite impracticable by the Laws of *Matter and Motion*: But this is exactly the preſent Caſe, and therefore the Production of an Animal is altogether *immechanical.* 3. Allowing Animals might have been produc'd by the caſual concourſe of *Atoms*, why do not theſe very ſame Cauſes continually operate, and why do we not ſee the ſame Effects in our Days (ſince the Cauſes continue the ſame) that were beheld in former Times? If any of the *Philoſophers* ſhould ſhew us ſuch an Appearance, nay, if they would but tell us (without running upon Contradictions) how ſuch a *Machin* might be produc'd, we might begin to hearken to their Pretences. But ſince ſuch a Thing was never ſeen nor pretended, it's very arrogant in them to think People ſhould believe the Matter, without any Reaſon, upon their meer Word. No Body now-a-days, that underſtands any thing of Nature or *Philoſophy*, can ſo much as imagin, that any Animal, how abject ſoever, can be produc'd by an *equivocal Generation*, or without the conjunction of Male and Female Parents, in the ſame, or in two different Individuals. And very few, who have conſider'd the Matter, but own, that every Animal proceeds from a pre-exiſtent *Animalcul*; and that the Parents conduce nothing but a convenient Habitation, and ſuitable Nouriſhment to it, till it be fit to be truſted with the Light, and capable of receiving the Benefit of the Air. We know very well, that there is nothing in the *Animal Machin* but an infinity of branching and winding Canals, fill'd with Liquors of different Natures, going the ſame perpetual round, which are no more capable of producing the wonderful Fabrick of another Animal, than a thing is of making it ſelf. Beſides, in the *Generation* of an Animal, there is a neceſſity that the *Head, Heart, Nerves, Veins* and *Arteries* ſhould be form'd at the ſame time, which can never be done by the Motion of any Fluid what way ſoever mov'd; for as hath been juſt now ſaid, the *Heart* cannot move, unleſs Animal Spirits be ſent from the *Head* through the *Nerves* into it: The Animal Spirits cannot be deriv'd into the *Heart*, unleſs the Blood be ſqueez'd by the *Heart* through the *Arteries* into the *Brain*. So that it is evident, that the *Head* and *Heart*, the *Arteries*, *Veins* and *Nerves* muſt be all formed at the ſame time, if the Animal is *Mechanically* produc'd: But this is altogether impoſſible; for no Motion of any Fluid or Fluids howſoever diſpos'd, can form all theſe at the ſame inſtant; and we know all the internal *Mechanical* Actions of Animals, are perform'd by the Force of their Fluids. Let any one conſider the *Infinity* of Canals, and other Organical Parts in an Animal; and again conſider, that all that one Animal can conduce toward the *Generation* of another, is by the force of ſome Liquors through ſome Canals, and try if from this Power he be able to form the Idea of the *Generation* of an Animal. It is doing Pennance, to read the wretched Accounts of the wiſeſt and moſt learned *Philoſophers* on this Head: To obſerve, how in every ſtep they contradict the known Laws of Motion; and indeed, the manner after which they would have 'em generated, is as much above the Power and beyond the Laws of *Mechaniſm*, as the true and genuin Manner and Method of their Production is. From all theſe Conſiderations it is evident, that an Animal cannot be produced mechanically; it is too hard a Problem to be ſolv'd from ſo few *data* as Matter and Motion; for indeed, could this one be once ſolv'd by any of the *Philoſophers*, we ſhould be eaſily ſatisfy'd of the reſt; tho' Plants, and all the vegetable Kingdom be liable to the ſame Difficulties, and furniſh us with the ſame Objections; for they are indeed only Animals of a lower Rank. And could it be once prov'd, either by *Demonſtration*, or by *Matter of Fact*, that a Plant or an Animal can be produc'd by *Mechaniſm*, *i. e.* Nature, or the Laws of Motion, the thoughtful parts of Mankind would be eaſily tempted to believe, that ſince the better part was produc'd by Mechaniſm, the meaner, *i. e.* all the reſt of this viſible World, might have been form'd the ſame way. So that it is a Matter of the greateſt Conſequence, that we have demonſtrated, that neither Animals nor Vegetables can be produc'd *Mechanically*. There are many other Arguments which I can produce, to prove the ſame Propoſition, which the Language I write in will not permit me to ſet forth.

§ XI. The *Spontaneous* Motions of the ſenſitive part of this *Syſtem*, is an eternal Contradiction to the Laws of *Mechaniſm*. We have ſufficiently ſhewn, that neither *Spontaneous* (nor indeed any) Motion is eſſential to Matter; it is determin'd to one Direction (while in Motion) which it can no more alter than move of it ſelf. This our Senſes may daily inform us of: The Ball goes on in the Direction of the Stick, or of the Body of the Piece out of which it is ſhot; the Arrow in that given it by the Bowſtring; and the Hand of the Dial-Plate in that given it by the Wheels; and that neceſſarily and conſtantly, if not forc'd out of the ſame by ſome foreign Violence: But all *Senſitive* Animals have a *ſelf-motion*, can turn and wind, move thro' all the Points of the Compaſs, go back and forward, as their Occaſions require, or Inclination prompts 'em. It's true, ſome of our Modern *Philoſophers* have aſſerted, that the *Brute-Creation* are only Pieces of Clock-work, and all their Motions are as neceſſarily determin'd as that of the Hand on the Dial-plate; but this Aſſertion is altogether precarious, and maybe deny'd as eaſily as its alledg'd. Beſides, the Demonſtrations *à priori* I have juſt now brought to evince the contrary, the Obſervation and Experience of all Mankind contradicts it; the *Docility* and *Sagacity* of ſome Animals demonſtrate the contrary, and ſome *Brute-Animals* ſhew more Indications of it than ſome of the Race of Mankind on whom they beſtow it. What more evident Proofs of a *ſpontaneous* Motion could theſe poor Creatures give than they do, if they were really ſuppos'd to be endow'd with it? Nothing but a Senſation in our ſelves of the *Principle* of their Actions could create clearer Evidences of a *ſpontaneous* Motion. Beſides, it is altogether impoſſible to account for the far greater part of their Actions and Motions from *Mechaniſm*, as we have in the preceding Propoſitions ſhewn at large. And we ſhould be ſtrangely ſurpriz'd, if by any Combination of material Organs, we ſhould produce the ſmalleſt part of their Actions and Paſſions. Wherefore, ſince the ſenſitive World is endow'd with *ſpontaneous* Motions, and ſince this is far beyond and above the Powers of Matter, it is evident this Univerſe could not have been produc'd *Mechanically*.

§ XII. The *Voluntary Motions* of Rational Creatures are altogether unaccountable from the Laws of *Mechaniſm*. Muſcular Motion is perform'd much after ſuch a manner as this: (If the moſt probable of our Modern Conjectures in this Matter have any Certainty in them) the Muſcles are Bundles of Fibres, which being cloſely compacted at both ends, terminate in their two *Tendons*, each of which is inſerted into ſome one fix'd part of the Body or other: Every one of theſe Fibres conſiſts of a prodigious number of leſſer Fibres, or *Fibrils*, which are ſo many very ſlender elaſtick Canals bound about by ſmall tranſverſe parallel or Spiral Threads, which divide theſe hollow *Fibrils* into ſo many elaſtick *Cyſtes* or *Veſiculæ*, as if a Gut were ty'd at equal Diſtances. Into every one of theſe *Veſiculæ*, an Artery, Vein, and Nerve enter; the two firſt to bring and carry back the Blood, the latter to carry thither likewiſe its proper Fluid or Spirit; which mixing in the *Veſiculæ* with the Blood, produces a Rarefaction (the manner how, for avoiding Diſputes, I ſhall forbear at preſent to determin) whereby theſe *Veſiculæ* are diſtended, and their *Longitudinal Diameters* (from Knot to Knot) ſtraitned, and ſo the length of the whole Muſcle ſhortned. The Nerves are the *ſecretory* Ducts of the *glandulous* Subſtance of the Brain, and conſequently, are much of the ſame Nature with the other *Excretories* of the Body, which are nothing but ſmall ſlender ſlips of the Arteries, for deriving an appropriated Juice or Spirit from the Blood Wherefore, ſince the nervous Juice or Spirit is form'd out of the Blood, and ſince the Nerves are very ſmall arterial Tubes this Spirit very probably muſt move in theſe Nerves after the ſame manner the Blood does in the Arteries, only with this difference, that it moves abundantly more ſlow (its Velocity being abated, either by the many Circumvolutions of the Artery in the *Gland*, which is the Origin of the Nerve, or by the reſiſtance the Juice meets with in the ſlender Pipe of the Nerve it ſelf). If the *Circulation* of the Blood be admitted, and all the Juices of the Body be allow'd to be deriv'd from it, 'tis impoſſible that any of theſe Juices ſhould ſtagnate in their Veſſels longer than till they be fill'd; and therefore, the nervous Juice in its Chanels is propell'd after the ſame manner and by the ſame Mechaniſm the Blood is urg'd forward in the Arteries. Now in the Muſcles of involuntary Motion, ſuch as the Heart, the Lungs, the Stomach and Guts, and the muſcular Coats of the Veſſels, this nervous Juice or Spirit is conſtantly derived by a *Mechanical* Neceſſity. In the Heart, while the *Auricles* are full of Blood, they are diſtended, and the influence of the nervous Juices into their Muſcles thereby ſtop'd; but when once this Blood begins to flow into the *Ventricles*, the reſiſtance ariſing from the diſtenſion of the *Auricles* to the influx of the nervous Juice is taken off, and ſo it flows into the muſcular Subſtance of the *Auricles*, and thereby they are contracted while the *Ventricles* are diſtended, and the influx of the nervous Juice into their Muſcles is thereby ſtop'd, till the Blood be deriv'd into the *Aorta*, and the Impediment from this diſtenſion to the influx of the nervous

Juice be taken off, and ſo the *Ventricles* come into Contraction; which hinders the Blood from running any more into the *Ventricles* from the *Auricles*, and then the *Auricles* are again filled: And thus, by a *Mechanical* Neceſſity, they act *alternately*, the *Auricles* and *Ventricles* being as it were *Antagoniſts* to one another; ſo as that while theſe are diſtended thoſe are contracted, the diſtenſion of the firſt permitting the influence of the nervous Juices into the latter; and ſo on the other hand. After the ſame manner are the *muſcular* Coats of the Blood-Veſſels' and of the Coats of the other Veſſels containing Liquors deriv'd from the Blood, *alternately* contracted and dilated; for by the Contraction of the Heart the Blood is thrown into the Arteries, which diſtends them, and ſo the influence of the nervous Juice into their Muſcular Coat is hindred; but when the Blood is by the *impetus* it has conceiv'd, deriv'd into the Veins, this impediment is taken off, and the Muſcular Coats of the Arteries then act, the *Membranous* by their *Elaſticity* concurring. In the Lungs the Gravity of the *Atmoſphere* forces the Air into the ſmall orbicular Veſicles thereof, and dilates the Cavity of the Breaſt; whereby the preſſure of its ſides upon them, and the Nerves that act in this Function is taken off, and ſo the Muſcles of the *Diaphragm* and the other concurring ones are at freedom to act, and to diſtend the Cavity of the *Thorax*, till the preſſure of the ſides of the Breaſt become too ſtrong for theſe oppoſite combin'd dilating Cauſes; and then by their own Gravity, and the elaſtick Force of the Ribs, they fall down and compreſs the Lungs, and ſhut up the Emiſſaries of the Nerves. So likewiſe in the Stomach and Guts, when the *Longitudinal Muſcular* Fibres are in Action, the *Tranſverſe* and *Spiral* ones are relax'd by the preſſure of the acting Fibres upon the Emiſſaries of the Nerves of the relax'd ones; and ſo on the other hand, when thoſe are relax'd theſe are in action, and univerſally in all the *involuntary* Motions there is a *Mechanical* Neceſſity for the derivation of the nervous Juices into the Muſcles employ'd in theſe Motions. But in voluntary Motions there neither is nor can be any ſuch Mechanical Neceſſity, it being a plain Contradiction to their Nature; and therefore voluntary Motion is quite contrary to the Laws of *Mechaniſm*; we can move our Hands and Feet how and when we pleaſe in an inſtant, we can bend and unbend 'em as we will; there is no *Mechanical* Cauſe imaginable to force this nervous Juice into the Muſcles of voluntary Motion, and no Motion can follow unleſs this Juice be deriv'd; as is plain from hence, that cutting the Nerves that ſerve any Muſcle, tho' all other things continue the ſame, yet no Motion will follow. And the only Conception we can form of voluntary Motions is, that the Mind, like a skilful *Muſician*, ſtrikes upon that Nerve which conveys Animal Spirits to the Muſcle to be contracted, and adds a greater Force than the natural to the nervous Juice; whereby it opens its Paſſage into the Veſicles of which the Muſcular Fibres conſiſt, which it could not have done by its natural Power. But this Action of the Mind or Will upon theſe Animal Spirits, being altogether unaccountable from the Laws of Motion, it is plain, that voluntary Motion is altogether *Immechanical*: And indeed, were it *Mechanical* it could not be Voluntary; for whatever acts *Mechanically*, acts conſtantly and neceſſarily, and ſo can never act voluntarily.

§ XIII. That *Freedom* and *Liberty* of chooſing or refuſing which we find in our ſelves, is altogether inconſiſtent with *Mechaniſm*. Some Men indeed deny that we have any Free-will at all; but theſe need only examin their own Conſciences to be convinc'd of their miſtake; they will find, that even when their Reaſon would determin 'em to do ſuch a thing, they have in their Power to forbear it, or to do the contrary; they can riſe or ſit ſtill, go backward or forward, to ſhew their own *Freedom*; they can chuſe the Time and Place, the Degrees and Circumſtances of all theſe Actions that are called Free. It's true, ſome of our natural Actions are neceſſary, but theſe which are commonly call'd voluntary Actions, are as much free as the nature of things will permit them.

Their Power being limited, I would gladly know, what greater *Indications* of Freedom they could wiſh to have, than they now have. The Paſſions of Mankind (which in moſt determin their Actions) are indeed violent, but they have it in their Power to ſuſpend for ſome time the ſatisfying of them; which ſhews, they are not neceſſarily determin'd toward their Satisfaction; for the Action of neceſſary Agents can only be ſuſpended by a Miracle. Let us ſuppoſe, that Man, in a perfect ſtate of Health, is free, and has a Power of *Election*: The only *Indications* he could give of this Freedom are, by doing the contrary, where there are weighty and ſolid Reaſons for doing ſuch a thing; or by making an *Election* among many things, when there is no imaginable Reaſon to determin him more to one than another; or to be able to ſuſpend the effect of natural Actions, when without this interpoſition they would *Mechanically* operate. Now it's certain that we are capable of giving all theſe *Indications*, to ſhew our Freedom: We have it in our Power to hurt or even deſtroy our ſelves, tho' there be the beſt Reaſons in the World to hinder us from ſo doing, we can take out the one and not the other, in two or more of the ſame things in all Circumſtances alike: Tho' *Reſpiration* be reckoned an involuntary Action, and tho' it is certainly perform'd *mechanically* and uniformly, yet we have it in our Power to keep in our Breaths, and to ſuſpend the efficacy of this natural *Function* for ſome time; and this ſeems to be one of the moſt evident *Indications* of Freedom that can poſſibly be deſired: For tho' in other Caſes it may be alledg'd, that it is the ſubtil and *imperceptible* manner after which we are determined, that makes any of our Actions ſeem free, yet in this Inſtance that Objection can have no place; for if we are determin'd ever ſo *imperceptibly*, it is by the Neceſſity of Nature we are determin'd. Now it is abſurd to think, that Nature ſhould determin any natural *Function* to be perform'd regularly and conſtantly the ſame way, and that by *Mechanical* Laws, and at the ſame time determin this *Function* to be irregularly and uncertainly ſuſpended. On the other hand, if we are neceſſarily determin'd in all our Actions, and if we have no Freedom, it is abſolutely impoſſible we ſhould make any Election among things in all Circumſtances alike; for if we are determin'd, it can only be from the things themſelves without us, for all things within us are, upon this *Hypotheſis*, to be ſuppos'd to move uniformly and *Mechanically*. Now where the things without us are in all Circumſtances alike, we can never be determin'd to any one of 'em by themſelves; and therefore were we not free, we could never make an Election among things altogether alike. By things altogether alike, I mean ſuch as are alike as to all the Circumſtances neceſſary to conſtitute them the things requir'd. Thus two Farthings are altogether alike, tho' they may differ in ſome ſmall Circumſtances that do not concern the *Eſſence* of that *Species* of Coin. Thus 1, 3, 5, 9, are equally odd Numbers, and 2, 4, 6, 8, are equally even Numbers, and if 'twere propos'd to aſſign an even or odd Number, there are infinitely many which are equally ſuch. The ſame thing happens in the Anſwers to all theſe *Problems*, which are call'd *indetermin'd*; and in aſſigning one of the Anſwers to any ſuch *Problems*, there is nothing in their Nature that can poſſibly determin us, the Conditions of the Problem being had reſpect to; and therefore ſuch things as theſe are only pitch'd upon by the energy of our Wills or Freedom. In a word, *Freedom* conſiſts not in doing any thing, or every thing, for thus even the *Supreme Being* is not free,it being impoſſible for Him to do Evil; but in varying and diverſifying infinitely different ways, the Manner and Circumſtances of what may be done, and chuſing without conſtraint, or from any Motive foreign to the Party chuſing. But no Arguments will make a Man confeſs he feels,if he be obſtinately reſolv'd not to confeſs it: now Liberty is a thing felt,and is only to be found by a *Reflection* on our ſelves and our Actions; but there is one Argument which will always have weight with the wiſer and better part of Mankind; and that is, that without Free-will, Virtue and Vice, Juſtice and Injuſtice are only bare Words. Now if Rational Creatures be free, as moſt certainly they are, this Freedom is a plain downright Contradiction to *Mechaniſm*; for *Mechaniſm* produces all its Effects neceſſarily.

CHAP. IV.

Of the Eternal Production and Duration of this preſent State of Things.

§ I. HAving, I think, ſufficiently ſhewn the Inconſiſtency and Impoſſibility of the *Epicurean Scheme.* I come to the ſecond Opinion about the *Origination* of the Univerſe; which in few Words tells us very poſitively; "That this preſent ſtate of Things has been "from all *Eternity* of it ſelf, ſo as we now "behold it; and that any Changes that have "have happen'd therein, have proceed-"ed from the Laws of *Mechaniſm* that now "obtain in the World." This *Scheme* conſiſts principally of theſe two Parts. 1. That this World has been for *ever* in the State we now behold it. 2. That it has been ſo for *ever* of it ſelf, independent of any other Cauſe. This Opinion is commonly, but falſly aſcrib'd to *Ariſtotle,* not as its firſt *Broacher,* but as its ableſt *Patron.* But tho' *Ariſtotle* held the firſt part of it, *viz.* That the World was from all *Eternity*, as we now behold it, yet he did not think it was ſo *of it ſelf*; and there is a very great difference betwixt allowing this preſent *Syſtem* of the *Univerſe* to have been created from all *Eternity* by an *Omnipotent Cauſe*, and believing it to have been for *ever* of it ſelf without any *Cauſe*. My Deſign in the following Diſcourſe, is not to diſpute againſt any *Scheme* of thoſe who admit the Exiſtencc of a *Deity*; I intend only to ſhew, That this preſent ſtate of things could not have been from all *Eternity*, neither of it ſelf, nor without the frequent and particular interpoſition of a *Divine Power*, and to make it plain, that naturally, and of it ſelf, it tends to *Diſſolution*: Tho' in the mean time, it is not to be doubted, but that that *Almighty Power* which could create this *beautiful Syſtem* of things, can preſerve it in being as long as He pleaſes.

§ II. That this Univerſe could never have been from all *Eternity* of it ſelf, in the preſent Condition it now is, is evident from hence, that it requires an *extrinſick Principle* for its ſubſiſting in its preſent Condition. If one ſhould ſee a Piece of *Clock-work*, pointing out the Diviſions of Time exactly and regularly, he might have ſome Difficulties about the manner of its Production; but if he ſhould ſee or learn, that it requir'd ſome *Foreign Aſſiſtance* to keep it going, that its Motion depended upon ſome Principle without it ſelf, that it requir'd winding up of the Spring or Weights, he would be ſoon ſatisfy'd it could not have been from all

Eternity of it ſelf in the ſtate he then beheld it. Now this is the very Condition of the *Earth*, the *Moon* and *Planets*, and of all the *Celeſtial* and *Terreſtrial* Appearances: Their Motions and Actions depend upon a Principle quite *extrinſick* to Matter, which ariſes from none of its Powers or Properties, as has been ſhown in the former *Chapter*. The Power which produces and preſerves their Motions, ſprings from ſomething without themſelves; and if this Power were ſuſpended or withdrawn, they would immediately ſtop, and their Motions would be deſtroy'd, and they would become a lifeleſs unactive heap of Matter. And this Power is nothing elſe but that univerſal Law of *Gravitation*, which *actuates* the whole Frame of all the *Syſtems* of Bodies, which proceeds from a Source both independent of, and diſtinct from Matter and all its Faculties. Wherefore, it is altogether impoſſible this preſent ſtate of things ſhould have been from all *Eternity of it ſelf*, ſince at preſent it cannot ſubſiſt in a regular and beautiful *Syſtem*, without the perpetual influence of ſome ſuperior and *extrinſick* Power.

§ III. When one thing depends upon another thing, as its *Cauſe*; as alſo, when one thing is neceſſarily requir'd for the Exiſtence or Preſervation of another thing, theſe can hardly be ſuppos'd to have been from all *Eternity of themſelves*; but much more likely ſeem to imply

Counſel and Deſign, and conſequently, to flow from the Wiſdom and Power of ſome *Intelligent* Being: For *Self exiſtence* neceſſarily implies Independency, as to Exiſtence on any other thing, either as Cauſe or as Effect; (I mean only of thoſe things which are about us, *viz.* the viſible things of this World, which have but Qualities both finite in Number and Degree; and conſequently, have *aſſignable* relations to, and dependences upon one another; for it is otherwiſe in the *Immenſe Being*, in reſpect of his Creatures, which can have no proportion to Him, and He no dependence on them) and when a thing depends upon another thing as its Cauſe, this implies, that the firſt thing exiſts that the ſecond *may exiſt*; which ſuppoſes Deſign and Contrivance, and conſequently is a ſign of Production or Creation, and not of the Self-exiſtence of theſe things. Likewiſe, when a thing is neceſſarily requir'd for the Exiſtence or Preſervation of another, it plainly implies, that the firſt thing exiſts that the ſecond *may exiſt*; which likewiſe ſuppoſes *Deſign* and *Contrivance*, and conſequently, can be no ſign of *Self-exiſtence* in theſe things. Now is there any thing more plain, than that moſt of the things in this our *Syſtem* are neceſſary or uſeful towards the Being or Preſervation of *Mankind?* Remove the *Sun* from us, or us from the *Sun*, the Earth could bring forth no Fruits for our Support; take away the *Moon*, the

Seas would ſtagnate and the Fiſh be deſtroy'd; level our *Mountains* we ſhould have no freſh Waters; deſtroy our *Atmoſphere*, or the Air's Elaſticity, we ſhould ſwell like poiſon'd Rats. Do not theſe, and a thouſand other Inſtances I could alledge, demonſtrate, that all the Beings of this Univerſe exiſt as the neceſſary Effect, or for the Exiſtence or Preſervation of other Beings, and conſequently, imply *Contrivance* and *Deſign*; which is a moſt evident ſign, that all theſe things have been produc'd, and are not Self-exiſtent. If a wild *Scythian* or *Indian*, who never ſaw a Houſe in his Life, ſhould meet with a *noble Palace*, neatly finiſh'd and finely furniſh'd, and about it ſhould find Creatures that could not ſubſiſt without ſuch a Convenience, and ſhould plainly diſcover, that the Accommodations and Conveniencies of this *Building* were exactly ſuited, in every Circumſtance, to the Wants and Neceſſities of theſe Creatures; I think he would have no difficulty in concluding, that this Houſe was built by ſome wiſe *Architect* for the Convenience of theſe Creatures, he would certainly never dream, that it had for ever been there of it ſelf ſo as he then beheld it. Now this is the very Caſe betwixt us, and the *Syſtem* of things about us: They have all relations and regards to us in our preſent ſtate, and to one another; there is a regular Subordination and Subſerviency among all the Parts, they all conſpire to great and beneficial Ends: In a word, There is not ſo much as a ſupernumerary, ſuperfluous or uſeleſs *Atom* in the whole great and complicated *Machin* of the Univerſe; every Age diſcovering new *final* Cauſes, and every the leaſt Object diſplaying ſome new Utility or Beauty, to thoſe *who ſeek out the Works of the Lord, and take pleaſure therein*: So that it is impoſſible, that thoſe who with due Preparation apply themſelves to them, ſhould ever think they could be of themſelves, or did not owe their Being to an *All-wiſe* and *All-powerful* Original. Not that the whole *Syſtem* of the Univerſe was contrived for the Race of Mankind alone; but that ſince their Utility and Conveniency being ſo plainly and fully conſulted, in their preſent ſtate, there can remain no doubt, that the whole *Syſtem* of Beings has been equally provided for in this wonderful Contrivance.

§ IV. That *Animals* could not have been from all *Eternity* is plain, for both the Reaſons alledg'd in the two former *Sections*. For, Firſt, Their Production and Exiſtence depend upon Principles quite extrinſick from, and independent of themſelves, I mean of their *Material part*. I have formerly ſhown, that they can neither ſubſiſt, nor be produc'd by the Powers of *Mechaniſm*; but for both require the conſtant influence of a Principle, even different from that which governs the inanimated part of the Univerſe, *viz*. *Gravitation*. Now all that is obſervable in this World (according to this *Scheme*) is Matter and Motion (for if we once allow a Power diſtinct from theſe, we ruin this *Hypotheſis*; for we do not then know how far the influence of this Power may reach, as to the Production and Preſervation of the preſent ſtate of things.) But the Production and Preſervation of *Animals* is above the Powers of Matter, as has been formerly ſhown; and therefore, ſince they depend upon a Principle diſtinct from, and independent of the Laws of *Mechaniſm*, and need a continual influence of ſome Principle, diſtinct from Matter and its Properties, they could not have been for ever of themſelves. Secondly, All the ſeveral Parts and Organs of the Animal Body, are ſo prudently adapted to the Benefit of the whole *Compoſitum*, as plainly implies Deſign and Contrivance, that it is impoſſible to conſider this, and imagin they have been Self-exiſtent. How wiſely are the *Bones articulated?* How prudently the *Muſcles* contriv'd, and how conveniently faſtned to the ſeveral Places of the Body to produce the neceſſary Motions? With what Judgment are the *Arteries*, *Veins* and *Nerves* ranged? With what Wiſdom are their Fluids diſpos'd in their proper Veſſels? How carefully is the Propagation of the *Species* provided for, according to ſeveral Circumſtances ariſing from the particular Climate and Element each *Animal* is confin'd to, and how juſtly is every

Particular adapted for the benefit of the whole Compound? I ſhall have occaſion to purſue theſe Inſtances farther hereafter; but any Body who is ever ſo little acquainted with the *ſtructure* of an *Animal*, cannot but diſcover evident Footſteps of *Deſign and Contrivance* in it, and therefore Animals cannot be Self exiſtent. Theſe, with the preceding Conſiderations on this Head, make it very improbable, if not impoſſible, the preſent ſtate of things ſhould have been for ever of themſelves, without an *Omnipotent* and *Omniſcient Original*. I come in the next place to thoſe Conſiderations that ſeem to imply, That this preſent ſtate of things is naturally, and of it ſelf, tending to Decay and Diſſolution, and conſequently, that it muſt of Neceſſity have had a *Beginning*.

§ V. It has been formerly ſhown, in *Section* XXVIII of the preceding *Chapter*, and its *Corollary*, that ſome part of the Nouriſhment of *Animals* and *Vegetables*, and the greateſt part requir'd to the Production of *Minerals* and *Metals* is a watry Fluid, impregnated with ſome other Body, which, by proper Operations upon this Fluid, is chang'd into a ſolid Form, of which but a very ſmall part is ever reſolv'd into Water again, whereby the quantity of Water on this our Globe is daily impair'd and diminiſh'd; wherefore, if the World had laſted from all *Eternity* in the State it now is, we had long ſince wanted both ſalt and freſh Water. This Decreaſe of watry Fluids on our Globe is ſo conſiderable, that Sir *Iſaac Newton* makes one uſe of *Comets*, in regard to us, to be to ſupply the Earth and other *Planets* with proper Materials for this purpoſe: For as the *Sea* is abſolutely neceſſary for the preſent State and Condition of our Globe, that from it, by the *Sun*'s Heat, Vapours may be ſo plentifully rais'd, that being collected into Clouds, they may fall into Rains, ſo as to water and nouriſh the Earth, for the Procreation of *Vegetables* of all kinds: Or being condenſed on the cooler Tops of Mountains, may fall through their Chinks into Baſons and Reſervatories, form'd by their hollow and open Texture, and thence into Rivulets and Rivers. So likewiſe for the Supply and Preſervation of the *Sea*, and other Fluids in the *Planets*, the *Comets* ſeem requiſite, from whoſe condens'd Exhalations and Vapours, whatever Liquor is ſpent on Vegetation and Putrefaction, may be ſupply'd and reſtor'd; for all the Vegetables are nouriſh'd conſtantly by almoſt Liquids only, and from putrify'd Liquors there is a Slime conſtantly falling: Hence the Quantity and Bulk of dry Earth is continually increaſing, and the Fluids, if they were not ſupply'd elſewhere, would perpetually decreaſe, and at laſt fail. Now whereſoever the Decreaſe of the Fluids be fix'd, whether in the *Planets* or *Comets*, it's plain they do decreaſe in this our

Syſtem, and conſequently, had the World laſted from all *Eternity*, they muſt have fail'd e're now; for had the *Planets* wanted a regular Supply, ſince it is evident they have their Fluids continually turn'd into dry Earth by Vegetation and Putrefaction, had the World laſted from all *Eternity*, they had been more parch'd and dry than the Deſarts of *Arabia* 'ere this time. But ſuppoſing their Supply regular from the *Comets*, and let theſe *Comets* be as many as you pleaſe, leſs than infinite, yet ſtill, had the World laſted from all *Eternity*, theſe *Comets* muſt have been drain'd of all their Fluids,had they been nothing but Globes of Water, whereas we know they are Maſſes of ſolid dry Matter, like the *Planets*, with large groſs *Atmoſpheres*: So that it's evident, the liquid Subſtance in this our *Syſtem* of Bodies is continually decreaſing; which ſeems to imply, that this preſent ſtate of things is not ſo contriv'd as to laſt for ever, and ſo could not have been for ever.

§ VI. It has been prov'd likewiſe in the preceding *Chapter*, That the *Light* of the *Sun* does daily decreaſe, and that the Body of the *Sun* does continually grow cooler; the ſame may be ſaid of the *fix'd Stars*: Now had the *Sun* and *fix'd Stars* been from all *Eternity*, we ſhould have been reduc'd long before this time to a ſtate of utter Darkneſs. We are very certain, that the Rays of the *Sun* are impriſon'd in our *Plants* and *Vegetables*, in our *Metals* and *Mine-*

rals, and are retain'd by the Action of Bodies upon Light; and ſome part of them by their Separation from others, and their being impriſon'd in theſe Subſtances, and the Action of Bodies upon Light, are for ever hinder'd from returning to the Body of the *Sun*; even ſuppoſing it were poſſible, that any Rays emitted from that *Luminous Globe* could return thither again, which is not very probable, they being projected with ſuch a Force and Velocity, and retain'd by the *Attraction* of Bodies, where any oppoſe their Courſe, and proceeding for ever in their *Rectilinear* Direction, where no Bodies obſtruct them. We are certain likewiſe, that the *Fountain* of our Heat daily impairs; that the vaſt Body of the *Sun* is perpetually a-leſſening and a-cooling; not only by the fuming away of his Parts, but by the nearer Approach and ſtronger Action of *Comets* in their *Perihelia*, which carry off great Portions of his Heat and Subſtance. It is very probable, that theſe Specks and Clouds which appear and diſappear on the Face of the *Sun*, are Vapours which fume away, and fill the Spaces through which the *Planets* move, or are *attracted* by their *Atmoſpheres*; and the *Comets*, by their ſo near approach to the *Sun*, ſo as to enter into his *Atmoſphere*, muſt, without all doubt, carry off conſiderable Portions of this Subſtance; inſomuch, that Sir *Iſaac Newton* is of Opinion, that theſe *Comets* may at laſt fall into his Body, to rekindle and ſupply the Waſte: and that thoſe *fix'd Stars* that have diſappear'd, and now appear, may be ſuch-like *Suns*, rekindled by the Approach of a *Comet*, juſt returning with the fiery Spoils of the *Sun*. And tho' theſe Effects be not ſo conſiderable, as to become ſenſible in three or four thouſand Years (tho' if ancient Hiſtories be true, this abatement and diminution of the Light and Heat has not been inſenſible) yet, in an infinity of Ages (this diminution being ſtill ſomewhat) the *Sun* had been reduc'd to the Heat and Light of a Taper long 'ere this time; and we had been involv'd in a more than *Cimmerian* Darkneſs. But ſince we obſerve no ſuch Effect as this, it is plain the World has not laſted from all *Eternity*.

§ VII. But that which does infallibly demonſtrate, that this preſent ſtate of things both had a beginning, and that of themſelves they muſt have an end, is, That our *Earth*, the *Planets*, the *Sun* and *fix'd Stars* do not move in Spaces altogether void, but in ſuch that do make at leaſt ſome reſiſtance to their Motions, I have ſhewn in the preceding *Chapter*, that the Reaſon why, for example, the *Planets* move about the *Sun* is, that the Body of the *Sun* attracts theſe *Planets*, and likewiſe theſe *Planets* attract the *Sun*; and that (ſince the *Planets* deſcribe *Elliptick* Orbits about the *Sun*) the attractive Force of the *Sun* upon the *Planets* is *reciprocally*, as the *Squares* of the different diſtances of the *Elliptick* Orbit from the *Sun*'s Center in its *focus*. But that beſides, theſe *Planets* were driven at firſt, or at the beginning of their Motion (to ſpeak ſo) by a Force whoſe Direction made an Angle with the attractive Force; or that at the very ſame time the attractive Force of the *Sun* exerted it ſelf on theſe *Planets*, they were puſh'd along in right Lines, by a Force whoſe Direction was in ſome manner or other inclin'd to that of the Direction of the attractive Force of the *Sun*, otherwiſe they could never have revolv'd in Orbits. So that it's evident, the Motion of the *Planets* about the *Sun*, is compounded of two different Motions in two different Directions, either of which being deſtroy'd, the *Planets* muſt have fall'n into the *Sun*, or ſtray'd for ever in right Lines; and tho' the reſiſtance of the *Medium* cannot alter the *Centripetal* Motion, (ſo I call that whereby the *Planet* tends towards the *Sun*) yet if there be any reſiſtance in the *Medium* through which the *Planets* paſs, the *projectil* Motion (ſo I call the other) muſt decreaſe and (in an infinity of Ages) be deſtroy'd. Sir *Iſaac Newton* has indeed demonſtrated, that the *Celeſtial* Spaces thro' which the *Planetary* and *Cometary* Globes do move, muſt be void of all groſs material Fluids, which might make any ſenſible reſiſtance to them: For ſince all Fluids reſiſt according to their Denſities, or in proportion to the Matter they contain, as has been already mention'd: And ſince no ſenſible reſiſtance has been obſerved to the Motion of the *Planets* and *Comets*, but that they freely move through the Mundane Space, on all Hands, and in every Point of the Compaſs, without any ſenſible diminution of their Motion, of neceſſity the Spaces muſt be void of all groſs and ſenſible Fluids: Yet in the preſent Argument, unleſs theſe *Celeſtial* Spaces could be demonſtrated to be abſolutely and *Metaphyſically* void, in an infinity of Ages, ſome even ſenſible Reſiſtance muſt have been made to their Motions. I readily grant, that the preſent Frame of things is ſo wiſely contriv'd, that they may continue in their preſent Order, and obtain their appointed Ends for ſome thouſands of Years, without any ſenſible Alterations, and that their Uſefulneſs and Advantages do not depend on indiviſible Points. But when infinite Duration is the Queſtion, the Argument is conſiderably, if not infinitely alter'd. There are many Reaſons for ſuſpecting the *Celeſtial* Spaces, through which the *Planets* and *Comets* move, not to be abſolutely void. *Light* is a Fluid, as has been demonſtrated, and paſſes from the *fix'd Stars* to us, and from us to them, and through all the ſeveral *Syſtems*. The *Sun*, very probably, throws out ſome part of his Clouds and *Atmoſphere* on the *Planets*; the *Atmoſpheres* of the *Planets* are elaſtick, and tho' doubtleſs very rare at great Diſtances from the Surfaces of their Globes; ſo as that a *Sphere* of Air of an Inch *Diameter*, of the ſame Denſity as it is at the Surface of the Earth, if'twere expanded as much as the Air is at the height of a *ſemidiameter* of the Earth, would much more than fill all the *Sphere* within the Orbit of *Saturn:* Yet ſtill being elaſtick, they may tranſmit ſome thin Vapours into one another, as very probably they do, by all their (not altogether inſenſible) Actions on the *Animals* on our Globe. The *Comets* ſend Steams and Vapours from their Tails, ſufficient to ſupply the Expences of the Fluids in the *Planets*, as has been juſt now mention'd. All of them, *Planets* and *Comets*, have ſome ſecret Influences and Actions upon one another, even different from the bare Action of their *Attractions*; all which make it very probable, if not demonſtrable, that theſe Mundane Spaces are not abſolutely devoid of ſome extremely thin and rare Fluid, whoſe Action, tho' not ſenſible in any finite time, muſt have been ſufficient, in an infinity of Ages, to have deſtroy'd the *projectil* Motion; and conſequently, long 'ere now all the *Planets* and *Comets* had been broiling in the *Sun*, had the World laſted from all *Eternity*; which not having happen'd, it's plain this preſent ſtate of things has not laſted from all *Eternity*, in the Order we now behold it.

§ VIII. The real, tho' inſenſible Changes and Variations that happen to the *Celeſtial* Bodies in this our *Syſtem*, in reſpect to one another, in their Motions, Bulks, and mutual *Attractions*, amount to a convincing Proof, that the preſent ſtate of things was not intended to laſt for ever, and conſequently, could not have been from all *Eternity*. The Regular Deſcription of equal *Areas* in equal Times in the *Moon* (on which all the Philoſophy of her Motions and Appearances depend) is ſomewhat diſturbed by the Action of the *Sun*; beſides innumerable other Variations in her *Theory*, which have not all as yet been intirely collected or adjuſted: All which pretty nearly happen to the *Satellits*, with reſpect to their *primary Planets*: *Jupiter* and *Saturn* diſturbing each others Motions near their Conjunctions; and theſe two greater ones diſturbing the Motions of the leſſer, *Mercury*, *Venus*, the *Earth*, and *Mars*; ſo that their *Aphelia* are continually changing in a progreſſive Motion forward. The reaſon why the *Comets* move not in the *Zodiack* as the *Planets* do, is, that in their *Aphelia* they may be at the greateſt Diſtances from one another, and conſequently, may diſturb one another's Motions the leaſt that may be, by their mutual *Attractions*; notwithſtanding which they ſo far diſturb one another's Motions, as ſcarce ever to return in the ſame Orbit, or in the ſame periodical time exactly. That the Motions of the *Planets* are, or may be diſturbed by the *Comets*, in their return into the

Planetary Syſtem, is, on the Principles laid down in the foregoing *Chapter*, paſt all doubt; the Decreaſe of the *Sun*'s Heat, Light and Bulk, and conſequently, of his attractive Force, muſt at laſt leſſen the mean Motion of the *Planets* about him, and conſequently diſturb, alter and change the whole ſtate of the *Syſtem*. The Approach of ſome of the *Comets*, in their *Perihelia*, ſo near the *Sun*: the reſiſtance they meet with in their Motion by the *Sun*'s *Atmoſphere*, in ſo near an Approach; and the diſturbance and retardation of their Motions they meet with in their *Aphelia*, by their mutual *Attractions* (being ſo large in Bulk and many in Number as Obſervations ſhow them) all theſe Cauſes, I ſay, co-operating, muſt at laſt ſo weaken their Motion, and gradually bring them ſo near the *Sun* in their *Perihelia*, that they muſt at laſt drop into his Body, which muſt produce inconceivable Changes in this our *Planetary Syſtem*. The Vapours and Steams ſent from the *Atmoſpheres* of the *Sun* and *fix'd Stars*, and from the Tails of *Comets*, may, on the Surfaces of the *Planets*, be chang'd into Water and watry Spirits, and then by a ſhow of Heat, may be turn'd gradually into *Salts*, *Sulphurs*, Tinctures, Slime, Clay, Marle, Sand, Stones, *Corals*, and other Earthy Subſtances, and ſo increaſe the Bulk, Weight and *Attractions* of theſe *Planets* upon one another; and Dr *Halley*, by comparing ancient and modern Obſervations, has found, that the mean Motion of the *Moon*, compar'd with that of the Earth, is actually increas'd; which would ſeem to imply, that the Weight and attractive Force of the Earth is actually increas'd. Now tho' all theſe Changes be inſenſible in ſome hundreds or thouſands of Years, and tho' they be regularly irregular (ſo to ſpeak) and proceed from conſtant and uniform Cauſes, yet, in an infinity of Ages backward or forward, they muſt have made, or muſt make ſuch Changes in our *Syſtem*, as would not ſuit with the preſent Conſtitution of the animate or inanimate kind of Beings now exiſting; and plainly ſhow the preſent ſtate of things not calculated for *eternal Duration*, in the Condition we now behold 'em, and conſequently, that they could not have been for ever as they now be.

§ IX. I have obſerv'd in the former *Chapter*, That the beſt Image or Idea we could frame of the *Syſtem* of the Univerſe was, as of a *noble* and *immenſe Machin*, form'd upon the ſtricteſt Principles of a *Divine Geometry*, the Whole, and its ſeveral Parts adjuſted by Number, Weight and Meaſure, all conſpiring towards, and regularly attaining ſome great and magnificent Ends, whoſe Springs are an immaterial Principle (if I may ſo call that of *Gravitation*) which animates the whole and all its Parts; an Original Impreſs, or a conſtant efflux from the Divine *Energy*, which enables the whole, and all the ſeveral Parts, regularly, conſtantly and harmoniouſly to attain their deſtin'd Ends and Purpoſes. There are certainly remaining, on all the Works of Nature, infinitely many and overcomingly ſtrong and great Lineaments and Tracts of Wiſdom, Contrivance and Deſign, ſo wonderfully beautiful and raviſhing, that it muſt neceſſarily fill the Hearts of thoſe *who take pleaſure to ſearch out the Works of God*, with Joy, Love and Veneration for their All-perfect Original. But there are many Suſpicions ariſing from the preſent Conſtitution and Frame of the Univerſe; That it has already undergone, and may, for the future, undergo many Changes and Alterations from what it now appears; and conſequently, that it has neither laſted from all *Eternity* as it now is, nor is likely to continue for ever in its preſent ſtate. 1. Whatever elſe may be in this *Syſtem* of things, yet we are certain, its Parts and *Organs* are Material and Corporeal. Now it is not in the Nature of Material Organs to laſt for ever in the ſame ſtate, eſpecially if we join to this Conſideration, that there is no perfectly ſolid and compact Bodies, but that all the Bodies we know of have interſpers'd Pores and Vacuities, by which ſubtil Matter entering, muſt at laſt diſſolve and deſtroy the Forms of Material Bodies; and the *Celeſtial* Bodies being, in reaſon, to be ſuppos'd of the ſame Nature with thoſe about us, they muſt, in time, moulder away, corrupt and change their Forms and Figures, and at laſt a ſenſible Alteration muſt be induc'd upon the Face of things thereby. 2. Whence ſoever the Motions of the *Celeſtial* Bodies did ariſe, or are continued, yet the Change on the ſolid Bodies of the *Celeſtial* Globes muſt make great Changes in their Motions: For tho' it were true (as it is much to be doubted) that no Motion is loſt, yet if the Texture, Size and Solidity of the *Celeſtial* Bodies may be chang'd, there may ſuch Changes enſue on the Conſtitution of the *Syſtem,* as may make it quite a different thing from its preſent ſtate. 3. There are Suſpicions, That the preſent *Syſtem* has undergone ſome conſiderable Changes (whether naturally or ſupernaturally is not the Queſtion here) in reſpect of the preſent Set of Beings that inhabit, at leaſt, our *Planet.* The Groſſneſs, Opacity and Darkneſs at preſent on the Face of things, the denſe and dusky *Atmoſpheres* about the *Planets*, the Inclemency of the Seaſons, the Malignity in the Elements, the Poiſon in Animals, Vegetables and Minerals, all theſe ſeem to be the effects of ſome great Change induc'd on Nature, and not their State, as they immediately came out of the Hands of an infinitely wiſe, good, and powerful Being; and no Philoſophy but that of *Chriſtianity* can account for this, which acquaints us with the Degeneracy and Corruption of this preſent Set of Ration

Beings, in withdrawing their Love and Deſire from its proper Object, to wit, Infinite Perfection, and placing it on the Creatures, and thereby becoming groſs, ſenſual, opaque, and irregular, and ſo rendring the Change of the then Conſtitution of things neceſſary. Add to theſe the *Elliptick* Orbits of the *Planets*, their *ſpheroidical* Figures, the Obliquities of their *Æquatorial* to their *Ecliptick* Planes, the ruggedneſs and deformity of their Surfaces, the Suſpicions of ſome univerſal Change on the internal Texture, at leaſt of our Planet, the diſtant wandring of the *Comets*, and the extinction and re-kindling of the *fix'd Stars*; all theſe, and many more, ſuch as I could collect, ſeem in ſome meaſure deviations, from the Simplicity, Uniformity and Facility Nature would obſerve, if not forc'd out of her Meaſures, and are ſhrewd Suſpicions, that ſome great Changes have been made upon the Original Frame of our *Syſtem* at leaſt. Far be it from me from ſuggeſting the leaſt Hint towards leſſening or depreciating the infinite Wiſdom, Beauty and *Harmony*, undeniably appearing in all the Works of GOD: All I would inſinuate is, that there ſeems to appear *Veſtiges* of ſome Alterations in the Conſtitution and Frame of the Univerſe, (at leaſt of that part of it which principally reſpects the Human Race) from its primitive Luſtre and Beauty, and that *Paradiſaical* State wherein our Holy Religion informs us it was originally conſtituted. The Scripture-Account of the Nature of glorify'd Bodies, and of the *Paradiſe of the Faithful*, as alſo, of the Labour and Groans of the whole Creation under its preſent ſtate, accounts for what one who ſoberly and attentively looks into the natural Pravity of his own Heart, or into the preſent (in ſome ſmall degree) Gloomineſs, Perplexedneſs and Diſtortion of our *Syſtem*, cannot help to obſerve. All which ſeems evidently to hint to us, that the preſent Conſtitution neither has laſted, nor is to laſt for ever.

§ X. If the *fix'd Stars* be not actually infinite in their Number, then this preſent ſtate of things muſt, of neceſſity, both have had a Beginning, and muſt have an End. It's certain theſe luminous Bodies do mutually *attract* each other, ſince it's abſurd to imagin Matter not to be of the ſame uniform Nature every where; and it's as certain, that they do not revolve about any common Center or Centers, ſince they have been obſerv'd never to have varied their Situations or Diſtances from each other. Now if they be finite in Number, the terminating Bodies of the material part of the World muſt be all free from Attractions towards the void part, and ſo muſt be all approaching towards the *common Center of Gravity* of the whol and had the Frame of the World been eternal, they had long 'ere now all of 'em met there. *Space* indeed may be infinite in its extent, but there is no imaginable Reaſon to believe the Number of the *fix'd Stars* is infinite, nor the material part of the Univerſe boundleſs, ſince we have very good Reaſon to believe, that the ſolid Subſtance has a very ſmall Proportion to the Vacuities interſpers'd even in our *Syſtem*, and that the Matter of this Univerſe is almoſt nothing in reſpect of the containing Space, as has been inſinuated in the former *Chapter*. For ſince Space is infinite (as I ſhall hereafter demonſtrate) and ſince there's a neceſſity of admitting of actual Vacuities, as I have formerly ſhown, it's plain, Matter cannot be infinite in its extent, ſince thereby it is not equal to *Space*. I very much doubt, whether a real and true Infinite, in its proper and ſtrict Senſe, can be greater than another; the ſeveral Parts of Relative or Creaturely Infinites (ſo I call thoſe that are generated by an uniform, convergent, or divergent Series, *vide Chap.* 1. *Part* 2.) may have finite Proportions to one another, but true Infinite muſt be One only, to which nothing elſe can be equal. *Space* is infinite, as being the Place (to ſpeak ſo) of the *Divine Ubiquity*, and having ſome Connexion with the true, ſole and proper Infinite; but Matter, if it be infinite, muſt either be ſo by the Neceſſity of its own Nature, or by the Will of the *Creator*. Not by the Neceſſity of its own Nature, becauſe then it muſt be every where; which being already demonmonſtrated falſe, it's impoſſible it ſhould be infinite by the Neceſſity of its own Nature: For if it be true, that Matter is not every where, it is poſſible it might be no where; that is, it's poſſible it ſhould not be at all; and conſequently, it is impoſſible it ſhould be infinite by the Neceſſity of its own Nature. Not by the Will of the *Creator*; for then a Creature might be equal to its *Creator*, ſince the juſteſt Image we can form to our ſelves of the *Creator*, is Perfection, apply'd to abſolute Infinitude; and if abſolute Infinitude could be apply'd to a Creature, then no doubt Perfection might be alſo; ſo that then an infinitely perfect Creature might be poſſible, that is there might be two or more infinitely Perfects, which is a Contradiction. Beſides, could Matter be infinite, being of thoſe kinds of Infinites that have three Dimenſions: by the *Analogy* and Simplicity conſtantly obſerv'd by Nature in like Caſes, it muſt be ſimilar, and equal to the other actual Infinite, to wit, *Space*. Laſtly, Matter is limited, in its own Nature capable of actual Limitations and Diviſions, and ſeems properly deſign'd for the Limits of *Space*, which is, in its own Nature, unlimited; and conſequently, Matter ſeems not at all deſign'd to be infinite in its Extent. Now if Matter be not actually infinite, in a proper Senſe, ſince *Space* is ſo, and ſince the *fix'd Stars* are limited in their Bulks and Sizes, it is impoſſible they ſhould be infinite in their Number; for when the Sum is finite, and each ſingle Part or Diviſion of the Sum is finite, the Sum of the whole of ſuch Parts cannot be infinite. It is true, we can aſſign no Reaſon for a limited finite Number of *fix'd Stars*, and it is not impoſſible, but that their Number may be as great as Created finite Matter can amount to, ſince all the Works of God are immenſe, and worthy of Him who is Omnipotent. But ſtill they cannot amount to real and proper infinity in Number, ſince Matter ſeems not capable, in its own Nature, to be infinite, but deſign'd for the Bounds and Limits of infinite *Space*, and the Conveniency of the material groſſer part of *animated* Beings, who ſeem not to be infinite in their Number. Now if the *fix'd Stars* be finite in their Number, or the material part of this Univerſe limited in its extent, the Bodies at the Limits of the material part being quite free from *Attractions* upon the ſide toward the infinite Space, muſt yield to the *attracting* Force of the Bodies toward the *common Center of Gravity* of the material part, and the *Boundaries* yielding, the Bodies next them muſt do ſo likewiſe, and ſo on even to the Center; for nothing but an equal *Attraction* on all Hands can keep the *fix'd Stars* conſtant in their Places, and nothing but an infinite Number rang'd up and down the infinite Space can be ſufficient for this;

wherefore ſince it has been evidently demonſtrated, that the material part of this Univerſe is finite in its extent, if the World had laſted from all *Eternity*, the whole Matter of this Univerſe had been long before this time amaſs'd in the *common Center of Gravity*, and had there made a lifeleſs Heap; which not having happen'd, it's plain this World has not laſted from all *Eternity*, nor can of it ſelf continue to all *Eternity*. And it's not unlikely that the vaſt, if not immenſe Diſtances of the *fix'd Stars* from us and one another, has been deſign'd to retard this Effect, as long as the Deſigns of Providence may require.

§ XI. In the former part of this *Chapter*, I have demonſtrated the impoſſibility of the *Mechanical* Production of *Animals* and *Vegetables*; and I ſhall have occaſion in the following *Chapter* to make it evident, that every generated *Animal* is produc'd from a pre-exiſtent *Animalcul* of the ſame *Species*, and that every *Vegetable* ariſes from a ſmall Plant of the ſame kind. And it is impoſſible it can be otherwiſe, upon our Adverſary's *Scheme* of admitting nothing but Matter and Motion; for if *Animals* and *Vegetables* cannot be produc'd from theſe (and I have clearly prov'd they cannot) they muſt of neceſſity have been from all *Eternity*; and conſequently, that all the *Animals* and *Vegetables* that have exiſted, or ſhall exiſt, have actually been all included in the firſt of every *Spe*-

cies: Or, which is the ſame thing, that pitching upon any one *individual* of either kind, now exiſtent, that all the *Animals* or *Vegetables* that proceed from it, were included in it; and it, with all theſe, was included in that one from which it proceeded, and ſo on infinitely backwards; and conſequently, ſince there is no new Production, all that are, or ever have been of that *Species*, were once actually together included in one infinitely remote from this now pitch'd upon; and that any finitely or infinitely diſtant time (if they have ſo long exiſted) from their Generation or Production, all the *Animals* included in the firſt of every *Species* were there moving and living *Animalculs*, and all *Vegetables* included in the firſt of every Kind, were there actually growing and increaſing ſmall Plants. Now ſince every *Animal* and *Vegetable* has been prov'd to conſiſt of *Organs* in Number infinite (tho' if the *Organs* of *Animals* be only finite in Number, it will as effectually ſerve our preſent purpoſe) it is abſolutely impoſſible, any of the *Species* of *Animals* or *Vegetables* ſhould have exiſted from all *Eternity*; for then their Number muſt have been infinitely many, and the *Animalculs* and ſmall Plants, being *Organical* Bodies, and conſiſting of Parts, and thoſe infinitely many too, and being all included in the firſt of every *Species*, or thoſe infinitely diſtant from the preſent *Individuals*; theſe firſt ones of every *Species* muſt of neceſſity have been infinitely big, for infinitely many *Organical* Bodies, how ſmall ſoever, amaſs'd together in one Body, muſt make that Body infinitely big. It's true, that tho' an *Animal* or *Plant* conſiſts of an infinite Number of *Organical* Parts, yet their Sum, or the *Animal* or *Plant* is but of a finite Magnitude, either becauſe the laſt *Organs* are infinitely ſmall (as they really ſeem to be) or that infinite here is only meant in a general, or leſs rigorous Senſe, for indefinite, or ſo many that we cannot diſtinctly conceive their Number, or give a Reaſon for their Limits: But ſeeing theſe *Animalculs*, or *Seed-Plants*, in this Caſe muſt be finite, as conſiſting of Parts, tho' infinitely ſmall, yet infinitely many in the firſt Suppoſition, and of a finite Number of finite Parts in the ſecond Suppoſition; conſequently, had the World laſted from all *Eternity*, the firſt of every *Species* muſt have been infinitely big: So that unleſs we could admit the firſt of every *Species* of *Animals* and *Vegetables* to be infinitely big (and how abſurd ſuch an *Hypotheſis* is, I leave the Reader to judge) it is abſolutely impoſſible, that *Animals* and *Vegetables* ſhould have been from all *Eternity*; neither can I ſee how this Argument can be evaded, if we admit all *Animals* and *Vegetables* to proceed from pre-exiſtent ſmall *Individuals* of the ſame *Species*, included in the firſt of each kind. And it is impoſſible this can be otherwiſe, upon our

Adverſaries *Scheme*, if the *Mechanical* Production of theſe be impoſſible, which I think I have clearly demonſtrated.

§ XII. Had the World laſted from *all Eternity* as it now is, it is altogether impoſſible, but that *Arts* and *Sciences* muſt have been brought to a far greater Perfection than they have as yet attain'd. Let us take, for Inſtance, the *Mathematicks*: It is certain this Science has been more improv'd within theſe two hundred Years, than in all the time paſt before that, ſince we have any Records; and two or three hundred Years more, going on at the rate of thoſe laſt paſt, may carry 'em to a height which we cannot now imagin. Now it is altogether impoſſible the Improvements already made ſhould be loſt, ſeeing they contain things ſo abſolutely neceſſary to the *Accommodations* of Mankind; they will as ſoon forget the uſe of Houſes and Cloaths, as the Advantages to be reap'd from this *Science*; wherefore, had the World *Eternally* been, this Science had been brought to its utmoſt Perfection long 'ere now. It may be alledg'd, that *Inundations*, *Deluges*, *Wars* and *Peſtilences* might have deſtroy'd all the former Improvements, and then we ſhould have been left to begin anew. As for *Deluges*, it is impoſſible they ſhould have been Univerſal, *i. e.* Naturally and Mechanically impoſſible; for the only *Philoſophical* Account of an *Univerſal Deluge* hitherto aſſign'd, *viz.* that of Mr. *Whi-*

ſton's,

ſton's, depends intirely upon the Principles of *Gravitation*, which have been prov'd not to be *Mechanical*, in the Senſe us'd by our Adverſaries; and ſince there could be no *Univerſal Deluge* naturally, (and to allow a Principle above Nature, or the eſtabliſh'd Laws of *Mechaniſm*, is to yield the Cauſe) particular Inundations could never have been ſufficient to have obliterated the remains of Sciences, particularly of this one, which by Inſcriptions on *Medals*, by the Ruins of *Architecture*, by *Pillars*, *Inſtruments*, and *Machins*, might have been preſerved in deſpite of every thing but an Univerſal Conflagration. Beſides, it's meerly precarious, to ſay there have been Deluges that have done any conſiderable Damage to the whole Rational Creation, and may be deny'd with the ſame Reaſon it is affirm'd, ſince it is certain we have heard of none of any conſiderable Conſequence. It's true, there happen'd an *Univerſal Deluge* in *Noah*'s Days; but beſides, as I formerly ſaid, that this was not brought about naturally, we know not, if this and the other Sciences had arriv'd at any great Perfection before this Deluge happen'd. So that we are not certain, if the Perfection of *Arts* and *Sciences* has been much retarded upon this account. Wars and Peſtilences, it's true, have been and may be, but thoſe do not happen univerſally over the whole World at the ſame time; and there are always ſome

Countries and many particular Perſons who eſcape; ſo that it's impoſſible theſe things could have obliterated all the Remains of *Arts* and *Sciences*. I believe it almoſt impoſſible by any means, except *Annihilation*, or a general Conflagration, ſo to deface the Memory and Remains of all our modern Improvements, that ſome of 'em ſhould not laſt at leaſt ten thouſand Years to come; and yet its certain we have no evident Footſteps of Improvements older than three or four thouſand Years. In ſhort, this Argument holds good againſt every thing but *Univerſal Deluges*; and to admit or ſuppoſe any ſuch to have been, is to yield the Cauſe, ſince its impoſſible to explain ſuch by the Laws of *Mechaniſm*, or to account for them by Matter and Motion as things are now ſettled; and to quit theſe, or to allow any thing to have happen'd contrary to 'em, is to admit *Powers* ſuperior to them, which, for ought we know, might have produc'd that which they can now ſo powerfully alter. And tho' *Arts* and *Sciences* may have been at a ſtand for many Ages in ſome Countries, yet that is nothing to the whole Globe. For ſince that Principle which prompts ſome Men to improve *Arts* or *Sciences* they are inclin'd to, ſprings naturally in their Minds, according to the *Scheme* of our Adverſaries, and is neither imprinted upon them, nor were the things themſelves reveal'd to them by any ſuperior Beings; this Principle, in an infinity of Ages, without any *Univerſal Deluge*, or even any particular one of any great extent, muſt of Neceſſity have brought *Arts* and *Sciences*, and the other Accommodations of Life, to a much greater Perfection than we ſee they have now attain'd. From all which, duly weigh'd, it's plain this World has not *Eternally* been as it is now. And indeed, the Accounts of our Improvements anſwer very well to the time aſſign'd by *Moſes* for the Creation of the World.

§ XIII. If the Number of any *generated* thing, which we behold on this Globe, does either increaſe or diminiſh continually, in any finite Number of Years how great ſoever, by any finite Number how ſmall ſoever, then this World could not have been from all *Eternity*, in the preſent ſtate we now behold it. For had it increas'd in any finite Number of Years how great ſoever, by any Number how ſmall ſoever, long before this time their Number had been infinite; ſo that this poor *Mole-Hill* of a *Globe* had not been able to contain 'em: And had they decreas'd, their Number had been none at all, *i. e.* the whole Race had been extinguiſhed. But ſince neither of theſe has happen'd, it's plain the preſent ſtate of things has not been for ever. It's not eaſie to believe, for inſtance, that the Race of Mankind has been *ebbing* and *flowing*, without conſiderable increaſes or diminutions, from all *Eternity*. We are certain *Wars, Peſtilences* and *Diſeaſes*, and the other means of Deſtruction, have not been fewer for theſe 300 Years bypaſt, than ever they been ſince we have had Records; and yet it's plain, the Number of Mankind has conſiderably increas'd in that time. Sir *William Petty*, from Obſervations on Births and Burials has diſcover'd, that in 360 Years the Maſs of Mankind is doubled in theſe Countries. Had they thus increas'd from all *Eternity* in other Countries, all the *Planets* within our *Syſtem* had not been able to have contain'd them by this time; yea, if in many *millions* of Years they had but increas'd by an Unity continually, their Number had been infinite by this time. But it's plain, both the Number of Mankind, and that of other *Animals* and *Vegetables*, muſt have perpetually increas'd, if the World has been from all *Eternity* as it is at preſent. And ſince their Number is but finite at preſent, it's evident, this World has not been for ever as it now is. And indeed the preſent Number of Animals does anſwer very well to the common *Æra* of the Creation. Theſe two laſt Arguments I have ſubjoin'd, not as concluſive Proofs of the Production of this preſent Univerſe in time, but as concurring Confirmations of the former Arguments.

§ XIV. Laſtly,

§ XIV. Laſtly, How improbable is it, that this World ſhould have been from all *Eternity?* Is there any thing we ſee in any part of it, or even in the whole, that has any other Quality ſuitable to that *Cardinal* one of Self-exiſtence? We our ſelves are certainly the nobleſt part of this *Syſtem* we are acquainted with; and yet God knows how unfit any of us, or even our whole Race is, to have ſo extravagant a Compliment beſtow'd upon us as *Self-exiſtence*, when as we can ſcarce be ſaid to be at all, ſo very a Nothing our Lives are in reſpect of *Infinite Duration*. We might, with as much Reaſon, imagin Mankind *Omniſcient* or *Omnipotent* (which we know too well he is not) as *Self-exiſtent*; theſe Qualities cannot be ſeparated; where one is, all the reſt muſt neceſſarily be; for whoſoever is *Self-exiſtent*, muſt neceſſarily and independently be. *Neceſſarily*, becauſe depending only on himſelf alone for Being, he may be when and while he pleaſes: *Independently*, becauſe his Being, and all that's neceſſary to it, depend on himſelf alone. By *Self-exiſtence*, in its true and poſitive Senſe, I mean not only the not having a Cauſe of Being, which is but a Negative Quality, and concludes nothing Poſitive: But by *Self-exiſtence* here I mean *Self-origination* (if I may ſpeak ſo) or a poſitive Quality in ſome Being, *analogous* to, or ſomething of that Kind; as a Power to give a Being to another is. It is true, we have no adequate *Ideas* of *Infinity*, *Self-exiſtence*, *Creation*, and the like, and in their common Acceptation theſe are only Negative Qualities; but they muſt have Poſitive Meanings, or Ideas, anſwerable to them, and muſt in ſome one Being imply active and poſitive Qualities, in their proper and genuine Senſe, tho' we finite Creatures can form no Images of them; and therefore the poſitive Quality imply'd by *Self-exiſtence*, in its proper and eminent Senſe, muſt imply Activity, Power and Knowledge: For *Self-exiſtence* apply'd to an inanimate thing is a Contradiction, a ſelf-exiſtent Body is as impoſſible as a ſelf-moving Body; for a thing to owe its Being only to it ſelf, muſt imply more than meer Exiſtence, it muſt neceſſarily involve Power, Activity and Knowledge. *Vide Chap. 2d. Part 2d.* And conſequently, whoever neceſſarily and independently exiſts, muſt Be, in oppoſition of all others; and whoever is ſo, muſt be able to preſerve his Being in deſpite of all other Powers, *i. e.* muſt be *Omnipotent*: Whoever is *Omnipotent*, muſt know all things that are poſſible to be done or let alone; for he can never be ſuppos'd to do that which he knows not how to do, *i. e.* muſt be *Omniſcient*; and whoever is *Omnipotent* and *Omniſcient*, all things elſe muſt depend on him; for being ſo, he may make all things depend of him, if already they did not ſo. Beſides, other things muſt depend of him for the very ſame Reaſon, *viz.* becauſe he can make 'em do ſo. As alſo, whatever is *Omnipotent* and *Omniſcient*, depending on nothing, and having all things depending on him, muſt be ſupremely good and wiſe; becauſe he knows all things, can do all things, has no Reaſon nor Cauſe to determin him to any thing that's bad, ſince nothing can hurt him, nor any Power annoy him. So that it's very plain, that whoever is *ſelf-exiſtent* muſt poſſeſs all the other ſuitable Qualifications. And ſince we muſt of neceſſity admit ſomething to be *ſelf-exiſtent*, how much more reaſonable is it to believe, that that *immenſe Being*, which poſſeſſes all other Qualities ſuitable to that of *Self-Exiſtence*, has been from all *Eternity*; and when it was his Pleaſure, has created this noble Repreſentation of himſelf, *viz.* This beautiful State of things, which bears ſo viſible *Characters* of his infinite Power and Wiſdom, as ſhall abundantly be ſhewn hereafter. And this is the *third Opinion* about the *Origination* of the Univerſe, which muſt of neceſſity be true, ſince after the other two, which I have (I think) abundantly confuted, this is the only poſſible remaining Choice.

CHAP. V.

Of the Exiſtence of a Deity.

§ I. THAT there are no *Speculative Atheiſts*, to me ſeems as evident, as that no Body who has conſider'd the Matter, can be abſolutely convinc'd, that the three *Angles* of a *Triangle* are not equal to two *right ones.* The *Fool* indeed, *may have ſaid in his Heart there is no God*, *i. e.* lewd and vicious Men may have heartily wiſh'd within themſelves, that there were no ſecret Obſerver, nor that there might be any publick *Puniſhment* of their Crimes, becauſe it's their Intereſt there ſhould be neither: But that a Man of an ordinary Underſtanding, who has ſeriouſly ſet about the matter, and has duly weigh'd the Evidences for the *Being of a Deity*, ſhould at laſt come to a full Perſuaſion of his *Non-Exiſtence*, to me ſeems as impoſſible, as it is for one who has attentively read the firſt Book of *Euclid*, and rightly underſtood what he has read, to be convinc'd, that the Sum of the *Angles* of a *right lin'd Triangle*, can be more or leſs than two *right Angles*. It is true, moſt Men think nothing of the matter, and few give themſelves the trouble to enquire, whether there be a God or not; they think ſuch idle *Speculations* become thoſe only who know not how to live, and to make the beſt uſe of Life that may be. And of this kind of *Atheiſts* there is abundance in the World; for its certain we can never determin any thing about what we never or but very *ſlightly* think; and there are millions who live and die ignorant of many Self-evident Truths, becauſe they never took the pains to conſider them. But the being or not being of a Deity, is a Matter of that Moment to the Government of the World, the neceſſary Conſequences thereof do ſo nearly concern the Happineſs or Miſery of every *individual rational Creature*, and the Objects that inculcate the Conſideration of it are ſo many, ſo different, and ſo *conſpicuous*, that none but the wilfully blind can withſtand ſuch convincing Teſtimonies. Now tho' the *Demonſtration* of this *great Truth, viz.* that there is a *ſupreme Being*, who made and governs this preſent *Syſtem* of things, has employ'd the Care of many *wiſe* and *good* Men, ſo that none can doubt of it for want of ſufficient Proofs, who will but give themſelves leave to conſider; yet ſince the *Evidences* for it can never be too many, and ſince ſome are to be wrought upon by one ſort of Argument, others by another, I ſhall here ſet down thoſe which agreed beſt with my manner of thinking, which are founded on the *Principles* of a juſter *Philoſophy*, and a more genuine Explication of Nature, than was known till of late. And I have choſen this way of Reaſoning, the rather becauſe our modern *Atheiſts* have taken *Sanctuary* within the Bounds of *Natural Philoſophy*.

§ II. All the Arguments of the *preceeding Chapter*, are ſo many Proofs of the Exiſtence of a *ſupreme Power*, who made and governs this preſent *Syſtem of things*. For ſince this World could neither be produc'd by the caſual *Concourſe* of *Atoms*, neither could have been from all *Eternity* it ſelf, as it has been ſufficiently prov'd; and ſince that it now is no body doubts, of Neceſſity therefore it muſt have been produc'd or created, ſome time or another, by ſome pre-exiſting Power. Now ſince there is nothing elſe in being but *this World*, unleſs we admit that *ſupreme Power* we are now ſpeaking of; and ſince it could neither have been produc'd from the *fortuitous concourſe of Atoms*, nor have been from all *Eternity of it ſelf*; it muſt of neceſſity have been produced by that *ſupreme Power*, whoſe Being we now inquire into. Since then this *ſupreme Power*, of neceſſity muſt have created this beautiful *Syſtem* of things, and ſince exiſting independently, He muſt for ever be, and have been; therefore that *great Power* muſt neceſſarily now exiſt. All the Difficulty any rational Creature can have about the Exiſtence of a *Deity*, is how to conceive his having for ever been of himſelf without a Beginning. Now if we could avoid this Difficulty, by ſaying, that this *Syſtem* was produc'd by the caſual meeting of *Atoms*, or by alledging it to have for ever been of it ſelf, we might have ſome ſlight pretence for our *Infidelity*. But ſince this Difficulty does equally lie againſt all theſe three Suppoſitions (for if the World has been produc'd by the *caſual concourſe of Atoms*, then *a Void*, *Atoms*, and *Motion*, have for ever been, without a Beginning, of themſelves; if it has been from all *Eternity of it ſelf*, as it is, then the Caſe is plain, that we muſt allow ſomething to have been without a beginning *of it ſelf)* wherefore I ſay, ſince the very ſame Difficulty equally and unavoidably urges all the three Suppoſitions; is it not more reaſonable and *congruous* to allow that Being to have been for ever of it ſelf, without a beginning, to whom we may aſcribe, and who does neceſſarily poſſeſs all other ſuitable Perfections, rather than either of thoſe others, which we know are neither endow'd with, nor capable of ſuch eminent and tranſcendent Qualities? I will not ſay with *Des Cartes*, that becauſe in our Conception of a Being *infinitely perfect*, there mnſt be included *neceſſary* Exiſtence, that therefore ſuch a Being muſt of neceſſity *actually* exiſt. But ſure I am, ſince our main Difficulty in the Conception of the Exiſtence of a Being *abſolutely perfect*, is his neceſſary Exiſtence, or his having for ever been of himſelf, without a beginning; it is much more reaſonable to ſuppoſe that Being to have for ever been of himſelf, who neceſſarily poſſeſſes all other ſuitable Qualities, than thoſe who neither poſſeſs, nor are capable of any of 'em.

§ III. The *Exiſtence* of *Matter* is a plain *Demonſtration* of the *Exiſtence of a Deity.* I believe no body doubts, that there now exiſts a quantity of *ſolid Maſs*, out of which the *celeſtial and terreſtrial* Bodies were form'd; and tho' perhaps in our moſt ſolid Bodies there be more Pores than Parts, or more *Vacuity* than *Solidity*, yet there is ſtill ſufficient, not to permit us to doubt of the Exiſtence of Matter. Wherefore ſince Matter now actually is, whence or how came it firſt to *be?* It could never have been of it ſelf, ſince we are certain, that it is deſtitute of all *active* Qualities whatſoever. And *Self-Exiſtence*, in its proper and poſitive *Idea*, ſeems to involve (beſides having no Cauſe for the Being of the thing to which it is apply'd) ſome other active Qualities, as Power and Knowledge, as I have already hinted. But we have already prov'd, that Matter cannot move of *it ſelf*, nor when put in motion can it reſt of *it ſelf*, nor of *it ſelf* change its Courſe, nor alter its Direction; it can neither change its *Figure*, nor *Colour*, nor *Situation*; in a word, it is endu'd with no Property but Inactivity, which is a Negation. How abſurd is it then, to imagin it could have brought *it ſelf* into Being, when it can do juſt nothing *of it ſelf*? To conclude, could Matter be Self-exiſtent, even in the Negative Senſe of the Word, it muſt neceſſarily have been; and if neceſſarily, it muſt, from the Neceſſity of its Being, have been ever. and every where, that is, it muſt be Eternal and Infinite; from which, it's plain, that it muſt have been every where *Uniform*, all Variety of Forms being a Contradiction to Neceſſity; it muſt have alſo been immoveable, for had it neceſſarily mov'd in any one Direction. with a determin'd Velocity, by the ſame Neceſſity it muſt have mov'd in a different Direction with a different Velocity, which being impoſſible, it could not have mov'd at all; for both theſe are ſuch Contradictions to Senſe and Reaſon, as none but an *Atheiſt* can ſwallow. We may as reaſonably imagin, that *Non-entity* ſhould bring it ſelf to become a poſitive Being, as conceive it poſſible, that Matter ſhould, of *it ſelf*, for ever have been. Beſides, admitting Matter to have been for ever of it ſelf, yet this will not ſolve half the Difficulties ariſing in the Formation and Production of the preſent State of things, as has been ſhewn in the *preceding Chapter*, and ſhall be now farther illuſtrated. Whereas the admitting of an *infinitely Powerful and Perfect Being* to have for *ever* been, and to have created the *ſolid Maſs*, and out of it to have framed this wonderful *Syſtem* of Things, contracts all the Difficulties of Nature into this one of his *Exiſtence*. For as to the Difficulties of Cre-

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ation, they vaniſh quite before *infinite* Power; for Power implies a Capacity to act, and *infinite* Power a Capacity to act every thing not involving a Contradiction. Wherefore ſince Matter now actually is, and yet it neither could have been for ever of it ſelf, nor had it for ever been, would that remove the Difficulties ariſing in the Formation of this preſent *Syſtem of things*, but, on the contrary, would multiply 'em: is it not much more reaſonable then, to admit an infinitely wiſe Being to have been for ever *of himſelf?* Whereby all the Difficulties, in the conceiving the Manner of the Production of this *Univerſe*, do vaniſh at once.

§ IV. It has been formerly ſhewn, that this *Univerſe* was not form'd by the ſame Laws it is now govern'd, and which its ſeveral Parts in their Actions do now obey; and therefore, of neceſſity there muſt have been ſome Power ſuperior to, and diſtinct from that of Matter, which form'd this *Syſtem* at firſt, and preſcrib'd Laws for its Parts afterwards to obſerve. We ſee all the Changes that now happen in this material World, are according to the Laws eſtabliſhed in the *firſt Chapter*. But this *Syſtem* of Things could never have been brought into its preſent Order, by the now eſtabliſh'd Laws of Nature (even admitting Matter to have been *eternally exiſtent of it ſelf*) as I have abundantly ſhewn in the *firſt Chapter*; neither one, nor all of theſe Laws were ſufficient to have ſeparated that thin and rare fluid of *Light*, from the other groſſer and more denſe ones, and amaſs'd it in the *Sun* and *fix'd Stars*; neither did the Laws of ſpecifick Gravity obtain in the *Formation* and *Situation* of the inner Parts of our *Earth*, and the other *Planets*; nor in the *Separation* and *Situation* of the ſeveral Fluids thereof. By none of the known Laws of Motion was the *Number*, *Magnitudes*, or Diſtances of the *fix'd Stars* determin'd, the Figure, Number, Denſities, Gravitations upon one another, Situations and Order of the *Planets* adjuſted, the Number, Diſtances and Magnitudes of the *Satellits of Jupiter*, the Form and Bulk of the *Annulus* of *Saturn* limited. In a word, the whole proceſs of the *Formation* of the *celeſtial* and *terreſtrial* World, as to their principal Parts and Arrangements, could be brought about by none of the Laws of Motion and *Mechaniſm*, that now obtain in this ſettled ſtate of things; or at moſt theſe Laws had but a ſmall ſhare in their Production. Wherefore ſince this beautiful *State of things* has not been for ever *of it ſelf*, nor could be form'd by the Powers and Laws of Nature, it is plain it has been produc'd by ſomething ſuperior to Matter and its Qualities: and conſequently, by that *ſupreme* Being, into whoſe *Exiſtence* we are now inquiring. And truly, from what has been here ſaid, and a great deal more of the ſame nature, alledg'd in the *firſt Chapter*, it is evident, we can have no Notion of the *Formation* of this preſent State of things, other than what we have of a *Planetary Clock*, or any other complicated *Machin*, form'd by the Hand of a skilful *Artiſt*; where tho' the Rules of

Motion, and Laws of Nature may obtain, when it is adjuſted and finiſhed: the Parts of the *Machin*, their Figures, Sizes and Proportions, and the connexion and fitting the whole, was brought about by voluntary Operations, different from, and ſometimes contrary to the Law of Nature and Motion, whereby it now ſubſiſts a regular *Machin*, and performs its intended Operations; which, nevertheleſs, it is not of it ſelf able to perpetuate, without frequent interpoſals of the ſame voluntary Powers, and the removal of thoſe Obſtructions and Diſturbances, Time, and the frail Nature of material Organs muſt bring upon it. And tho' this, no doubt, be but an infinitely low and faint Reſemblance of that *noble* and glorious Work, yet it is the beſt and moſt adequate our *Imaginations*, without running upon evident Contradictions, can frame.

§ V. As the Formation and Diſpoſition of the *great Bodies* of this Univerſe, did neceſſarily require the Hand of a Being infinitely Powerful; ſo likewiſe did their firſt Movement, and impreſs'd Motions, demand the Impulſe of an Almighty Hand to ſet them firſt a-going. For ſuppoſing the *celeſtial* Bodies already form'd, and rang'd according to their ſeveral Diſtances from one another; yet without this Impulſe, they had continued unactive, unmoving Heaps of Matter. Now it has been already ſhewn, that no Particle of Matter, nor any *Combination* of Particles can move themſelves, and therefore it was abſolutely neceſſary, that ſomething different from themſelves ſhould put them in a Motion, with a due Velocity, along the *Tangents* of their ſeveral *Orbits*; otherwiſe they had for ever continued in the Places, and at the Diſtances they were at firſt ſet. Wherefore ſince it is certain, that theſe *glorious Bodies* have been rolling about theſe four or five thouſand Years; and ſince it hath been demonſtrated, that they are not ſelf-moving, being *ſolid Maſſes of Matter*; ſince it has likewiſe been ſhewn, that they have been ſet a-going by ſome powerful Hand; and what Hand ſufficient for ſuch a Work, but his who is Infinite, both in Strength and Skill? and conſequently, he who did ſo *great and glorious* Things muſt neceſſarily *be*.

§ VI. Not only the *Formation*, and firſt *impulſe* of the great Bodies of this Univerſe, along the *Tangents* of their *Orbits*, but their *Centripetal* impulſes, whereby their Revolutions, or *orbicular* Motions, are perform'd, did, and ſtill do, require a Power beyond that of Matter and the Laws of Nature, to the preſervation of their Motion. Sir *Iſaac Newton* has demonſtrated, that to the Motion of any of the *Celeſtial* Bodies in an *Orbit*, there is neceſſarily required two Impulſes, one along the *Tangent* of the *Orbit*, another toward the Center, about which the Body moves The firſt being once impreſt, does continually perſevere, and needs no more to be renew'd, as is evident from the firſt Law of Nature: The ſecond continually draws the *celeſtial* Body from its *rectilinear* Motion, and forces it into a *curvilinear* Orbit, ſo that it muſt be repeated every Minute of Time. Now theſe *ſecondary* Impulſes ariſe from that *Univerſal Principle of Attraction,* whereby every Particle of Matter, and all the Bodies of this Univerſe tend toward one another; and by which the *Sun,* being the far greateſt Body of this our *Syſtem,* draws toward him the *Planets,* and they their own *Sattelits,* and without which they would for ever wander in right Lines. But it has been demonſtrated in the *firſt Chapter,* that this Principle, whereby the *Revolutions* of theſe glorious Bodies are perform'd, is independent of the Laws of *Mechaniſm,* and only accidental (no ways *eſſential*) to Matter, but implanted therein by ſome extrinſick Power, and conſequently (ſince it muſt be repeated every Minute) muſt be perpetuated in it by ſome uninterrupted Influence, or by the perſevering *Energy* of the firſt Impreſſion. And ſeeing there is nothing in Nature, but Matter, and the Powers thereof, unleſs we admit that ſupreme Being for whoſe Exiſtence we contend; therefore the Revolutions of the *celeſtial* Bodies, in their ſeveral *Orbits,* do neceſſarily infer the Exiſtence of a Deity.

§ VII. The *Exiſtence* of *Animals* does neceſſarily infer the *Exiſtence* of a *Deity*; for it has been demonſtrated in the *former Chapter,* that all Animals are, in their own Natures, *perpetua mobilia,* that they have ſome Principle above the Power of Matter that governs their Motions; it has likewiſe been ſhewn, that every *individual Plant* and *Animal* is a *Machin* of an infinite number of Organs; that no Animal is or can be produc'd duc'd or generated by the Force of Matter and Laws of *Mechaniſm* (that all *Animals* and *Vegetables* that ever were or ſhall be, were all created, or form'd at once, as ſhall be afterward ſhewn) and that all theſe are abſolutely unaccountable from the Laws of Motion, and conſequently, muſt ſpring from a Principle independent of, and altogether above the Powers and Properties of Matter. Now whenever we forſake the Powers of Matter, and the Laws of *Mechaniſm*, we neceſſarily muſt have Recourſe to the *Exiſtence* of ſome Power ſuperior to, and independent of Matter, and all its Laws and Properties, and conſequently, to that *infinitely Perfect Being*, into whoſe Exiſtence we are now inquiring; ſince there is nothing beſides Matter and its Properties in the World, unleſs we admit the Exiſtence of that *ſupreme Being*.

§ VIII. The *ſpontaneous* Motions of *irrational*, and the voluntary Motions of *rational* Animals, the *Freedom of Will*, and liberty of chuſing or refuſing in the latter; and, in a word, all the *Appearances* of Nature, which are above the Powers of *Mechaniſm* (which are innumerable) are ſo many undeniable Proofs of the *Being* of a *God*. For ſince this preſent *Syſtem* of Things has not been from all *Eternity of it ſelf*, and ſince theſe are allow'd to be above the Powers of *Mechaniſm*, they muſt have been produced by ſome Power Superior to thoſe of *Mechaniſm*. But no Power is ſufficient for thoſe, but his *who alone does great and marvellous things*; who adjuſted all the Parts of this noble *Fabrick* by Number, Weight and Meaſure, and therefore he that brought about all theſe glorious things, *He who alone does Wonders*, muſt neceſſarily *be*.

§ IX. The Preſervation of the *Being* and Faculties, both of the animate and inanimate Part of this *Syſtem* of things, does neceſſarily require the Power, and conſequently, the *Exiſtence* of a Being abſolutely perfect, *i. e.* of a Deity. For ſince this *Syſtem* of things has not been from all *Eternity* of it ſelf, as we now behold it; and ſince there is no neceſſary Connexion between the being of any one Part thereof, or of its Faculties, this preſent Moment, and their being the next; and ſince we ſee both have been preſerv'd for a conſiderable time: This Preſervation of the *Being* and Faculties of things can never be accounted for, without having Recourſe to an *Almighty* Power, which may be ſufficient for all things not involving a Contradiction; and therefore that *Omnipotent* Being, endow'd with this Power, muſt neceſſarily *be*. It is true, Things (as they are now conſtituted by *infinite Power* and *Perfection*,) once brought into Being with ſuch and ſuch eſſential Qualities, may be ſuppos'd to perſevere and continue in Being, and in Poſſeſſion of their Qualities till ſome Cauſe deſtroy them, or alter their Natures; but, if we reflect upon the poſſible manner of their *now* Being, that is, the Preſervation of their Being and Qualities, it can never be conceiv'd without having Recourſe to an infinite Power. For either things now being, were for ever ſo: *That is*, were *ſelf-exiſtent*, *that is*, are neceſſarily exiſtent, *that*, *is*, are incapable of Motion or Variety of Forms as I have formerly ſhewn, which is a Contradiction. Or they were brought into Being by an infinite Power; *that is*, had an active *energy* impreſs'd on them, to perſevere in their Being; *that is*, are continu'd in Being by Virtue of an *original Impreſs* from an *Almighty Power*; *that is*, owe neither their firſt Being, nor their Being *now*, to themſelves nor their eſſential Natures, but to an Almighty *Fiat*, which both produced them into Being, and impreſs'd on them a Power or Virtue to continue their Being, which, if poſſible, being ſubſtracted, they wou'd without any orher Cauſe ſink into their Primitive Nothing. Without all Peradventure, *the Works and Gifts of God are without Repentance*, they are all immortal and eternal in their Beings, and eſſential Natures, as partaking of his own *Immortality*, and being all of them, in a higher or lower Degree, *Images* and *Copies* of his Being and communicable Perfections; and tho' poſſibly he might have given them different Natures and Conſtitutions at firſt, from what they now have; yet being now conſtituted and form'd into ſuch Beings, it may be doubted whether he can deſtroy the eſſential Natures of Things thus conſtituted, *annihilate* theſe he has made, or eſſentially alter their Natures, without counteracting himſelf; which ſeems a Contradiction in infinite Perfection. There is no Doubt, they may paſs through infinite Varieties of *Forms* and *Modifications*; and this our *Syſtem*, or the *Syſtem* of the whole Univerſe, with all its Inhabitants, may be changed into greatly different Shapes and Modifications; yet their eſſential and *generical* Natures muſt be preſerv'd and ſubſiſt for ever. Not by Virtue of their once being brought into *Exiſtence*, which may be conſider'd as a *Tranſient Act* that ſubſiſts no more, but by an active permanent Principle of *Immortality* (ſo to ſpeak) which is communicated to them from the Divine Nature, as being his Images, and Emanations from him, whereby being once brought into Exiſtence, they are enabled to continue in their Being and Natures. There is nothing more evident than that God cou'd create nothing but what ſhou'd be in a higher or lower Degree, an *Image* or *Copy* of his infinite Perfections. The Effect muſt have ſome Reſemblance to the Cauſe, but this can never reach *Independence* or *Self-exiſtence* in a proper and ſtrict Senſe, that were a plain Contradiction to *Creation* or being produc'd. So that Perſeverance in Being in Creatures, cannot be the neceſſary Conſequence of their Being, elſe being once produc'd, they wou'd neceſſarily continue in their Being, and become Independent for the Continuation of their Being, which is Inconſiſtent with the Nature of Creatures; but the continuance of their Being is, by a Virtue or *Energy*, deriv'd from the Divine Immortality, of which their being and perſevering in Exiſtence is a *Copy* and *Reſemblance*; and as the Divine *Immortality* is not a dead inactive Principle, like a *vis inertiæ*, ſo neither is the Copy thereof in Creatures, but a living active Principle, which once impreſs'd, preſerves created Things in their Being and eſſential Qualities without the neceſſity of a continual Interpoſition. This may be more eaſily underſtood by comparing it with the Nature of *Attraction* or *Gravitation*, and with the Nature of Motion in Bodies. I think it pretty evident that *Attraction* is not eſſential to Matter as ſuch: For were there an univerſal *Plenum*, or no vacuities in the amaſſed finite Quantity of Matter now being, and no Motion (neither of which imply a contradiction) then matter might be conceiv'd without Gravity, or at leaſt, it's Gravity without effect, which in an active Principle, is much the ſame thing: And therefore it is highly probable that Gravity is a divine *Energy* impreſs'd on Matter. Of the ſame kind of Qualities, in Bodies, is Motion. And all the Motions in the Univerſe, not depending on *Attraction*, muſt have been originally impreſſed by a Cauſe different from Matter, ſince it has been demonſtrated that Motion is not eſſential to Matter. Now it is plain Motion is an *active Principle*, which is continued by Virtue of the firſt *Impreſſion* and is not eſſential to Bodies: After the ſame manner likewiſe may *Attraction* be conceived to be. And with due regard to the different kinds of Qualities, in a proper *Ana-*

logy, we may Reaſon concerning that Principle of ſelf-preſervation in all created things, whereby being once brought into Exiſtence, they are enabled by virtue of the firſt *Energy* to preſerve for ever their Being and eſſential Qualities. And univerſally we may reaſon thus in a proper *Analogy* about all the Copies, or *Images*, in the Creatures, of the particular Divine Attributes communicated to them, except *Self-exiſtence* and *Independency*. They all, not being meerly *inertes potentiæ*, but Life and Activity being eſſential to them all, in a higher or lower degree. Now ſince this Principle of the *preſervation* of their Being and Qualities, does not flow from the Nature of things when brought into Exiſtence, (elſe they wou'd now being produc'd, exiſt neceſſarily) but ſuppoſes an *Energy* or active Principle communicated to them by which they continue to *be*; The Original of this communicated Principle, *the Great and Omnipotent Origin of all Being and Perfections* muſt neceſſarily *be*.

§ X. But that Argument for the *Exiſtence* of a *Being infinitely perfect*, who made and governs this *Syſtem* of things, which of all others affects me moſt, is that it is altogether impoſſible, this Univerſe cou'd have been better contriv'd or more compleatly finiſhed, than it is, had *infinite Wiſdom* firſt actually deſign'd it, and then put the

Deſign in execution. Or which is the ſame, there are legible and indelible *Characters* of *infinite Wiſdom*, in the *Contrivance* of the whole, and of the ſeveral Parts of this admirable Fabrick of the *Univerſe*; and it is altogether impoſſible for the united ſkill of Men and Angels, to mend any one Part, or to contrive it better, or even to find out any real Defect therein, due Regard being had to the univerſal Benefit of the whole *Syſtem*; and to the particular Natures and Diſpoſitions of the Inhabitants of it's ſeveral Parts. For in the Contrivance and Adjuſtment of the ſeveral Parts of this noble Machin, where the Choice is various, and ſometimes infinite, that one is pitch'd upon, which alone cou'd bring, the moſt advantages to the whole, or which only cou'd bring about the deſign'd Effect. This is a very large Subject, and to treat it according to it's Dignity requires far greater Abilities than I am Maſter of, and more Room, than the Limits I have preſcrib'd to my ſelf will admit. However, I ſhall endeavour to illuſtrate the ſame in the following Particulars. But firſt of all it will be convenient to lay down a general *Scheme* of this noble Structure.

§ XI. Let us then conceive the *Mundan Space*, or the univerſal Place of all Bodies, to be boundleſs in it's Extent, or indefinite in it's Dimenſions, and in it at vaſt Diſtances from one another, the fix'd Stars (huge luminous Bodies, like the Sun) to be plac'd: Keeping always the ſame Diſtances from one another, and moving only (perhaps) about their own *Axes*; about each of theſe let us imagine ſeveral Bodies like our *Planets*, rowling in ſeveral *Orbits* at ſeveral Diſtances; and about thoſe leſſer ones, *Analogous* to the *Satellits* of our *Planets*. Each of theſe fix'd Stars with their Circumambient *Planet-like Orbs*, conſtituting that which is call'd a *Syſtem* of the *Celeſtial* Bodies. And how many ſuch there muſt be in the vaſt extent of Space, a naked Eye in a cloudleſs Night, may give us ſome faint *Glimpſe*, but much more a good large *Teleſcope* directed towards that Region of the Sky, which is call'd the *milky way*. Our Numbers fall very ſhort here, and our *Arithmetick* can ſcarce give us an *Idea* of the vaſt Quantity of *Syſtems* that adorn this *ſtupendous* Piece of *Architecture*; and yet no doubt their Number is finite, and they are all included in a bounded Extenſion; for Matter ſeems not capable in it's Nature of being infinitely propagated. Moreover, let us conceive the glorious Body of the Sun, fix'd in the Center of Gravity (or near it) of this our *Syſtem*, and in the common Center of Motion (or *focus*) of all the *Planetary Orbits.* And then next to him *Mercury* ſhall make his *oval round*, but ſo near him, that we can rarely obtain a diſtinct View of him, he being ſwallow'd up almoſt in the Light of the *Sun.* Next to *Mercury*, is our beautiful Morning and Evening Star *Venus*: Next *Venus*, our *Earth*, with it's Attendant the *Moon*, perform their friendly Courſe, and meaſure out the Year. Beyond our *Earth* M*ars* ſingly and alone, revolves about the ſame Center; next to M*ars*, *Jupiter*, the largeſt of the *Planets*, with his four *Satellits* turn round in concert; and laſt of all, *Saturn* with his five Guards, and his ſurrounding *Annulus* or *Ring*, deſcribes the remoteſt *Orbit*, and concludes our *Syſtem.*

§ XII. For the eaſe of the Reader, in going through the following Parts of this Diſcourſe, I ſhall ſet down here the Numbers that repreſent the *Periods*, the *Diameters*, *Diſtances*, *Gravities*, and Quantities of Matter, in thoſe of the *Celeſtial* Bodies, which have afforded any Grounds for determining the ſame, as Mr. *Whiſton* has calculated moſt of them from the lateſt Obſervations, by Sir *Iſaac Newton*'s Rules.

The Periodical Times of each Planet's Revolution about the Sun.

		Y.	D.	H.
Mercury	Revolves about the Sun in the Space of	00	088	00
Venus		00	224	18
The *Earth*		00	365	06
Mars		01	315	00
Jupiter		13	000	00
Saturn.		30	000	00

The middle Diſtances of the Planets from the Sun.

Mercury	Is diſtant from the Sun.	020952000	Statute Miles each 5000 *Paris* Feet.
Venus		039096000	
The *Earth*		054000000	
Mars		082242000	
Jupiter		280582000	
Saturn.		51354000	

The Quantity of Matter *in, and the Gravity of ſuch of the heavenly Bodies (as afford* Means *for the determining the ſame,) at the ſome diſtance from the Center of the Sun, is as follows,*

The *Sun*'s	66690
Jupiter's	00060 $\frac{1}{2}$
Saturn's	00028 $\frac{1}{4}$
The *Earth*'s	00001
The Moon's	00000 $\frac{1}{26}$

The

The Diameters of the Sun and Planets.

The *Sun*'s	494100	Statute Miles each 5000 *Paris* Feet.
Saturn's	043925	
Jupiter's	052522	
Mars's	002816	
The *Earth*'s	008202	
The Moon's	002223	
Venus's	004941	
Mercury's	002717	

The Diameter of the Celeſtial Bodies in Engliſh Meaſures.

	Diameter.	
The *Sun*	822138	Engliſh Miles.
Mars	4875	
The *Moon*	2175	
Mercury	2748	
The *Earth*	7967	
Saturn	93451	
Jupiter	120653	

The weight of Bodies on the Surface of the Sun and Planets.

On the Surface of	The *Sun*	10000
	The *Earth*	01258½
	Jupiter	00804½
	The *Moon*	00630
	Saturn	00536

The Denſities of the Celeſtial Bodies.

The *Moon's*	700
The *Earth's*	387
The *Sun's*	100
Jupiter's	076
Saturn's	060

The Periodical Times of the Satellits of Jupiter.

1	2
1 d. 18 h. $28\frac{3}{5}$	3 d. 13 h. $17'\frac{9}{10}$

3	4
7 d. 3 h. $59'\frac{3}{8}$	16 d. 18 h. $5'\frac{1}{5}$.

The Diſtances of the Satellits from the Center of Jupiter.

	1	2	3	4	
Flamſted by the Eclipſes of the Satel.	5. 578	8. 876.	14. 159.	24. 903	Semidiameters of *Jupiter.*
From the Periodical Times.	5. 578	8. 873.	14. 168.	24. 968	

The Periodical Times of the Satellits of Saturn.

1	2
1 d. 21 h. 18′ 31″.	2 d. 16 h. 41′. 27″.

4 d.

3 4
4 d. 13 h. 47′. 16″. 15 d. 22 h. 41′ 11″.
5
79 d. 7 h. 53′ 57″.

The Diſtances of the Satellits from the Center of Saturn.

1	2	3	4	5	
$\frac{9}{40}$	$1\frac{1}{4}$	$1\frac{3}{4}$	$3\frac{1}{2}$	12.	Diameters of the Ring of *Saturn.*

The middle diſtance of the Earth *and Planets compar'd with their Periodical Times.*

	♄	♃	♂	♁	♀	☿
According to obſervation.	954198	522520	152350	100000	72398	38585.
According to the Periodical Terms	953806	520116	152399	100000	72333	38710.

The Times of the Revolutions of the Sun and Planets about their Axes.

The *Sun* in 25 Days
The Earth in 1 Day
The *Moon* in 29 Days

Jupiter in 10 hours
Mars in $24\frac{2}{3}$ hours
Venus in 23 hours.

§ XIII. What a *beautiful Scene* of things have we here? How ſimple, and yet how wonderful are the Works of Nature? Such like are all the Effects of infinite Wiſdom, her Foundations are plain and ſimple, but her *ſuperſtructure*, various and wonderful. Her Cauſes few, her Effects innumerable. Her Courſe the eaſieſt and ſhorteſt poſſible, and her Means the feweſt that can poſſibly bring about her Ends. Let us but conſult the Books of the old *Aſtronomers*, and we will then have ſufficient Ground to admire the frugal Simplicity of Nature, in this neat compact *Syſtem*; we ſhall ſee there what ſorry, perplex'd Work they made, with their *Cycles*, and *Epicycles*, their *carrying*, and *æquating*, their *Concentrick* and *Excentrick* Circles, their *Stations* and *Retrogradations*, their ſolid *Orbs*, and the perpetual Change of the *Axe* of Motion, in the celeſtial Appearances: Such a ſtrange *ungeometrical* and contradictory *Syſtem* they made of the *Heavens*; whereas from theſe few plain and ſimple Poſitions, all the Appearances of the *Heavens*, are accounted for, with wonderful Conſiſtency and Facility.

§ XIV. The *Sun* being a huge Body of *liquid Fire*, brought into fuſion by the Force of his Heat, and thereby ſending out *Oceans* of that thin, active Fluid, which is the *Medium* of Light, and the cauſe of all Heat, turns round his own *Axe*, from Weſt to Eaſt in about twenty five Days; which ariſes from his firſt Being put into ſuch a *Circumgyration*, after His having been ſeated in his Place. And there being little or no Reſiſtance in his Region to retard his Motion, it has continu'd ever ſince, and will do, 'till the *Conſummation* of all things; by Virtue of that firſt impreſs'd *Gyration*, and the firſt Law of Nature. His Motion about his own *Axe*, has been diſcover'd by *Spots* on his Surface, and his Fluidity, from his leſſer Denſity in reſpect of ſome of the ſolid *Planets*, (ſome ſolid Bodies being more denſe than moſt Fluids are) his *Sphæricity*, and that all Bodies heated to ſuch a Degree, as the *Sun* muſt neceſſarily be, muſt certainly be *vitrify'd*. That is moſt continue in a Fluid State as long as this violent Heat laſts. Beſides, the Fountain being in reaſon to be ſuppos'd of the ſame Nature with the Streams, ſince the *Rays of Light* are moſt certainly a thin, rare, active Fluid: Much of the ſame kind, with due regard to the Circumſtances, muſt the Light in the Body of the *Sun* be; the greateſt difficulty is to conceive how this *Globe* of liquid Fire ſhou'd be able to project his Beams with ſuch Velocity and Force, ſo as to be able to diſſolve every thing almoſt. That which may contribute to help our Imagination here, is what may be daily ſeen at a *Smith's Forge*, when the Iron is ſo much heated, as to run into *Fuſion*, it ſends out copiouſly, on all Hands, Streams of *liquid Fire*: All *ſulphurous* Bodies likewiſe

wiſe emit and iſſue out *liquid Flames*, or burning Smoak, which by reaſon of the greater Gravity of the *Circumambient Atmoſphere* is forced upwards, but if there were no *Atmoſphere*, theſe Flames wou'd be projected every way equally. Now as *Bodies* act upon *Light* by emitting, refracting, and reflecting it, ſo *Light* acts on *Bodies* in heating them, and putting their parts in a vibrating Motion wherein Heat conſiſts. And when their parts are thus heated, or put in *Vibrations*, beyond a certain Degree, they emit *Light*, and Shine, and this emiſſion is performed by the vibrating Motions of the Parts. So that ſuppoſing the *Sun* a great Body like our Earth vehemently heated, that is having it's Parts ſet into vehement *Vibrations*, theſe *Vibrations* of the parts of the *Earth* wou'd forceably project, and violently thruſt forth, immenſe *Oceans* of this ſubtile Fluid on all Hands. So that as Light produces theſe *Vibrations* on the parts of Bodies, theſe *Vibrations* in Bodies, are the cauſe of this emiſſion of *Light* on all Hands. Every ſingle particle in Bodies, when put in this vehement vibrating Motion propelling in it's turn and return of *Vibration*, a *Cylinder* of Light equal to it's Section tho' it's Center, and the Sum of all the particles of the heated Body urging ſo many ſuch *Cylinders* on all Hands as is the Number of ſuch vibrating Particles. The greater Quantity of Matter, and larger Dimenſions of the *Sun* in reſpect of the *Planets*, makes him ſufficient for all the Expenſes of Light, he lays out upon them, whereby his Bulk and Heat is conſtantly diminiſhing, as alſo, for drawing all the reſt of the *Planets* and their *Satellits* towards him; for as has been formerly inſinuated, the Force of *Attraction* of one Body upon ſeveral others, at the ſame Diſtance, is as their *Maſſes*, or Quantities of Matter: Wherefore ſeeing the *Sun* contains a greater Quantity of Matter by very far, than any of the *Planets*, the Sun muſt neceſſarily draw the *Planets* with their *Satellits* to him; which wou'd have unavoidably come to paſs, had not the *Planets* at the inſtant they were ſeated in their Places, receiv'd an impulſe, which drove 'em along the *Tangents* of their *Orbits*; and had not theſe two Motions been ſo exactly *Counterpoiſed*, that neither of them ſhou'd over-power the other. Theſe with the ſmall Reſiſtance they meet in their Courſes, and the Force of the Attraction diminiſhing as the Squares of their Diſtances increaſe, has made 'em ever ſince revolve in their *Elliptick Orbits*, in one of whoſe *Foci* the *Sun* is ſituated: And what is here ſaid of the Cauſe of the *Primary Planet's* Motions about the *Sun*, may be underſtood of the *ſecondary*

dary Planet's Motions, about the *Primary ones.* All the *Planets* revolve about the *Sun* in *Elliptick Orbits*, or ſuch as are not very far different from them; as alſo moſt of 'em, turn round their own *Axes* from Weſt to Eaſt; the *Earth* in Twenty Four Hours, about an *Axe*, which is inclin'd to the Plane of the *Ecliptick* 66½ Degrees: And in it's Motion about the *Sun*, this *Axe*, of the diurnal Rotation, obſerves always a *Paralleliſm* with it ſelf, the Reaſon of which is evident, for if a *Sphere* move about an *Axe*, this *Axe* (there being no other Motion ſuppos'd in the *Sphere*) is immoveable, while in the mean time every Point in the *Sphere*, deſcribes a Circle about this *Axe*, and therefore if a *Sphere* move either in a *curve*, or ſtrait Line, and at the ſame time turn round it's *Axe*, the *Axe* ſhall always continue *parallel* to that Line it was firſt *parallel* to; for that Impreſſion which perpetuates it's Rotation upon it's *Axe*, and the impulſe along the *Tangent* of it's *Orbit*, are two diſtinct Motions, which never interfere, and ſo each of them muſt continue the ſame as if the other were not; ſo that every Body turning about it's *Axe*, and at the ſame time deſcribing a Right or *Curve* Line, muſt of neceſſity retain it's *Axe parallel* to it ſelf, if nothing elſe diſturb it. *Jupiter* likewiſe, *Mars* and *Venus*, and our

Moon, do alſo turn round their *Axes*, from Weſt to Eaſt, and would retain this *Parallelism*, if not diſturb'd by *Foreign* Violence. The *Satellits of Jupiter* and *Saturn* do likewiſe turn round their *Axes*, as is evident from hence, that they, like our *Moon*, turn conſtantly the ſame Face or *Diſk* toward their *primary Planets*; and it is not improbable, that the others in which we have not had the Occaſion of obſerving the like, may alſo turn round their *Axes*; that in a Revolution about the *Sun*, they may in all their Parts oftner than once, enjoy his Light and Heat; for it is from this Rotation of our Earth upon it's *Axis*, that we have the *Viciſſitudes* of Day and Night, and from the P*arallelism* of the *Axis* to it ſelf, in the *Earth's* Revolution about the Sun, and it's being inclin'd to the Plane of the *Ecliptick*, come the beautiful *Seaſons* of the Year, *Summer* and *Winter*, *Spring* and *Autumn*, which are of ſuch comfort and uſe to it's Inhabitants. From the *Opacity* of the *Moon* and *Planets* and their *Satellits*, and the *Obliquity* of their Planes to the Plane of the *Ecliptick*, together with their diurnal and annual Motions; and ſome of 'em revolving in *Orbits*, within one another, their P*haſes*, their appearing and diſappearing, their total and partial *Eclipſes* ariſe.

§ XV. Since their *Solidity* and *Opacity*, the *Similar* Nature of their *Orbits*, and their *Satellitious* Attendance, their Revolutions about the *Sun*, and their Rotations about their *Axes*, their *Gravitations* and mutual *Attractions*, the Proportion of their Periods to their Diſtances from the Center of Motion, the *equable* Deſcription of *Area*'s in equal Times. Since, I ſay, all theſe and many more particulars are exactly the ſame in our *Earth*, and the other *Planets* with their *Satellits*, it is not improbable that they may be alike in other things, and that they may have Inhabitants both rational and irrational, Plants and Vegetables, Water and Fire *analogous* to, tho' not of the very ſame Nature and Conſtitution with ours; and ſince our *fix'd Stars* are exactly of the ſame Nature with our *Sun*, as ſhall be afterwards made appear, it is very likely that they have *Planets*, and theſe *Planets* have *Satellits*, and theſe *Planets* and *Satellits* have Inhabitants, rational and irrational, Plants and Vegetables, Water and Fire, *analogous* to thoſe in our *Syſtem*. On theſe Suppoſitions, which not only are not abſurd or contradictory; but on the contrary highly probable, as ſhall be afterwards made appear more fully; what a noble and glorious *Fabrick* wou'd preſent it ſelf to our Imaginations? How is it poſſible for any one who had this *Idea* of the *Univerſe*, to think it poſſible ſuch a beautiful *Syſtem*, cou'd have been produc'd without infinite Wiſdom? None but the wilful, or obſtinate cou'd reſiſt ſuch a powerful Impreſſion of divine Power and Wiſdom. On the other Hand, how is it poſſible to conceive that, that immenſe Number of glorious and Sun-like Bodies of the *fixt Stars*, thoſe *vaſt* and huge Bodies of ſome of the *Planets* (in reſpect of our *Earth*) with their noble *Attendance*, were made for no other uſe but to twinkle on us in Winter Evenings, and by their *Aſpects* to forebode what little Changes of Weather, or other pitiful Accidents were to be expected below, or to be peep'd at by ſome poor paltry Fellows of Aſtronomers? Or can any body force himſelf to think, that all *Animals* and *Plants*, have been exhauſted in furniſhing out this poor Corner, while the other more glorious, great and noble Parts, are left deſtitute and bare? Certainly they muſt have a great Opinion of themſelves, and of their own Habitation, who can think ſo poorly of the reſt of the Univerſe. It is true, from the great Reſemblance, and *Analogy*, between the *greater material World*, and the *leſſer* one, of an *Animal* Body; and from this *Hypotheſis*, of *new Worlds*, and *new Setts* of Living Creatures, it's bearing hard, upon the noble, and glorious *Oeconomy*, of the Redemption of lapſed Creatures: By confining it, to a *dirty Mole-hill* of a ſingle *Planet*, ſome pious and enlight'ned Perſons, have taught that as in an *Animal* Body, the *Brain*, the *Heart*, the *Lungs*, the *Liver*, the *Guts*, the *Spleen*, and all the *infinite Number* of *Conglobat* and *Conglomerat Glands*, had their ſeveral diſtinct uſes, for purifying, refining, and exalting, the neceſſary Juices and *Spirits*, or for ſecerning, and throwing off, the noxious ones; and yet all this Complex and *infinite* variety of noble and wonderfully contriv'd *Organs*, were deſign'd ſolely, for the preſervation of one *Animal* and the propagation of it's kind. So in the *greater material World*. All that *infinite* variety of *Stars*, and *Planets*, might be for purifying and ſubtiliſing, concocting and preparing the *Aſtral Influences* neceſſary for the *Preſervation*, *Propagation* and *comfortable Support* of the ſeveral *Setts* of Creatures Inhabiting this ſpoil'd, defaced, and ruinous Globe of the *Earth*. Whatever may be in this I ſhall proceed in ſuppoſing, the *Planets* to be Inhabited, and that the *fix'd Stars* have their *Planets* and Inhabitants, yet they are not of the ſame Nature and Conſtitution with thoſe of our Globe, as is evident from the different Degrees of Heat and Light they enjoy; as alſo from the different Viciſſitudes of their Day and Night, and the Seaſons of their Year. *Mercury* is three times nearer the *Sun*, than we, and conſequently enjoys nine times as much Heat and Light, he never removing Twenty Eight Degrees from the vaſt Body of Light. *Venus* enjoys twice as much Heat and Light, and her Motion about her *Axe* is perform'd in Twenty Three Hours, and ſo her Day is but one Hour leſs than ours; ſhe has all the *Phaſes* of our *Moon*, appearing ſometimes horn'd ſometimes halv'd. *Mars* has no Inclination in the *Axe* of his Rotation to the Plane of his *Orbit*, and conſequently enjoys a perpetual *Equinox*, but no viciſſitudes of Seaſons; he receives but the third Part of our Light and Heat. *Jupiter* likewiſe enjoys a perpetual *Equinox*, and and a Day of Ten Hours, but receives only the Twenty Fifth Part of our Heat, and *Saturn* but the Hundredth.

§ XVI. The *Satellits* of the ſeveral *Planets* ſuffer many and various Diſturbances in their Motions from the *Sun*, as alſo, the Primary *planets* ſuffer likewiſe from the Forces of the *Sun*, and of the ſecondary *Planets*. Thus the *Moon* (if acted upon only by the attractive Force of the *Earth*) wou'd by a *Ray* from the Center of the Earth, deſcribe equal *Area's* in equal times, wou'd about the *Earth* in one of it's *Foci*, deſcribe a perfect *Ellipſe* of the ſame *Species* conſtantly, whoſe Plane wou'd be immoveable, or always the ſame, and whoſe Inclination to the Plane of the *Ecliptick* wou'd never vary; but by the Action of the *Sun* upon the *Moon*, all theſe Effects are diſturb'd, for ſhe neither deſcribes equal *Area*'s in equal Times by a *Ray* from the Center of the Earth, but ſomewhat larger ones in her *Conjunctions* and *Oppoſitions* with the Sun than in her *Quadratures*. Neither is her *Orbit* always *ſpecifically* the ſame, nor is the *Earth* in any of the *Foci* of her *Orbits*; for they are more *Curve* about the *Quadratures*, and leſs toward her *Conjunctions* and *Oppoſitions*: In every Revolution ſhe deſcribes a new kind of *Curve*, and both the Situation of the Plane of her *Orbit*, and it's Inclination to the Plane of the *Ecliptick*, varies every Moment, and all theſe Uncertainties and Aberrations, are multiply'd by her nearer or remoter Diſtances from the *Sun*, beſides a great many other Irregularities too tedious here to relate. Upon the account of all which, it has been ſo very hard for *Aſtronomers*, to reduce her Motions to Rule, and to expreſs 'em in Numbers; and yet all theſe Irregularities are wonderfully accounted for, from the Action of the *Sun* and *Earth* upon her, upon the common Suppoſition of the Law of Attraction, ev'n to a Nicety, beyond which Obſervation cannot diſtinguiſh, as is evident from Sir *Iſaac Newton*'s *Theory* of the *Moon*, which is a ſurprizing Confirmation of the Truth of that Principle. On the other hand, the Force of the *Sun*, but eſpecially of the *Moon*, diſturbs the Motion of the *Earth*, as is evident from our *Tides*, which do ſo exactly follow the Motions of the *Moon*, that he who knows the former, with ſome few collateral Circumſtances, cannot be ignorant of the latter; for when the M*oon* comes to the vertical Point of any Place, we have a *Tide* there, as alſo on the Place *diametrically* oppoſite to it; this *Tide* is greater at the *Conjunctions* and *Oppoſitions* of the *Moon* to the *Sun*, than at her *Quadratures*, and greateſt of all at the *Equinoxes*, eſpecially if the *Moon* is then in her *Perigeum*, the Reaſons of all which I have ſuggeſted in *the ſecond Chapter*. And what is here ſaid of the *Earth*, with reſpect to the M*oon*, may be with due Limitations underſtood, of any *primary Planet*, in reſpect of it's *Satellits*.

§ XVII. That the *fix'd Stars* are Bodies like our *Sun*, all the late *Aſtronomers* agree, for it's plain they ſhine by their own Light, ſince it is altogether impoſſible, that the Light of the *Sun*, ſhou'd be ſent to them, and tranſmitted to us, ſo as to make them appear ſo lucid as we ſee them. We ſee how faintly in reſpect of ſome of the *fix'd Stars*, *Saturn* ſhines for all his Bulk; and yet his diſtance is but a Point in reſpect of the neareſt *fix'd Star*, from the *Sun*. The Rays of the *Sun* wou'd be ſo diſſipated before they reach'd ſo remote an Object, that the beſt Eye of the World, cou'd not by it, diſcover them. Their Diſtance is ſo great, that the beſt *Teleſcope*, inſtead of magnifying 'em above what they appear to the naked Eye (as they do any Object, remov'd by any menſurable Diſtance, how great ſoever) does conſiderably leſſen them, ſo that they appear like lucid Points. Beſides, tho' we in this Globe, approach nearer them ſome twenty four Thouſand *Diameters* of the Earth, (or 188304000 Miles, allowing five thouſand Feet to the Mile) one time of the Year than another, yet their *Parallax* is ſcarce ſenſible, if any at all, which cou'd not be, if they were at my moderate Diſtance: By Mr. *Hugen*'s Computation, the Diſtance of the *Sun* from us, is to the Diſtance of the neareſt *fix'd Stars* from us, as 1 to 27664, that is (allowing the Diſtance of the *Sun* from us to be 12000 *Diameters* of the Earth, and a *Diameter* to be of 7846 Miles, according to the beſt Calculations) the Diſtance of the neareſt *fix'd Star* from us, is at leaſt 240452092800 Miles, which a Cannon Bullet moving with the Velocity it has, when parted from the Muſle of the Piece, wou'd ſpend almoſt ſeven hundred thouſand Years to go through. Since then, both theſe are true, that they ſhine by their own Light, and that they are at ſuch an immenſe Diſtance from us, it is plain, they muſt be *Bodies* like our *Sun*; which wou'd be evident, cou'd they be brought near us, or we near them, for it is only the Diſtance that creates our doubt. Now this being true, it is impoſſible they ſhou'd be all in the Surface of the ſame *Sphere*, ſince our *Sun* which is one of 'em, cannot be reduc'd to this Rule. Beſides, their different Magnitudes, ſhew that they are at as immenſe Diſtances from one another, as the neareſt of 'em is from us. Let us but imagine our ſelves remov'd at an equal Diſtance from the *Sun*, and *fix'd Stars*, we ſhould then certainly perceive no difference between them; for as to all the *Planets*, that we ſee now attend the *Sun*, we ſhou'd not have the leaſt Glimpſe of them; both becauſe their Light wou'd be too weak to affect us, and becauſe all their Orbs wou'd be united, in that one lucid point of the *Sun*. In this Station, we ſhou'd have no occaſion to imagine any Difference between one *Star* and another, but ſhou'd certainly conclude both *Sun* and *fix'd Stars* of the ſame Nature; and knowing the Nature of one, we ſhou'd certainly conclude the ſame of all the reſt, *viz.* that if one was a lucid Globe of liquid Fire, ſo wou'd all the reſt be, and that they were at immenſe Diſtances from one another. If Mr. *Derham*'s Conjecture, about the appearing and diſappearing Stars (of which there are many Inſtances obſerv'd by *Aſtronomers*) be true, to wit, that they are *Planets*, belonging to ſome of the neareſt *fix'd Stars*; which become viſible, when they are in that part of their *Orbit*, next to our *Earth*, and diſappear when they remove, to that part of their *Orbit*, which is fartheſt from us. I ſay were this conjecture certain, as it is not improbable, then we had a certain confirmation of the modern *Theory* of the *Celeſtial* Bodies; but I am afraid if the *fix'd Stars* actually had *Planets*, and they *Satellits*, that at our Diſtance we cou'd hardly ſee either. Since then there are ſeveral probable Arguments, (ſome of which I hinted before) that they have Attendant *Planets*, and no poſſible one to evict the contrary, we may ſafely conclude that the *fix'd Stars* are ſo many *Suns* in the Center of a *Syſtem* of *Planets* and their *Satellits*.

§ XVIII. Beſides theſe already mentioned, there is another *Species* of Heavenly Bodies, call'd *Comets*, which revolve about the *Sun*; in very Oblong *Elliptick Orbits*, approaching to *Parabolick Curves*. The Times of their *Periodical* Revolutions are very long, ſince in three or four Thouſand Years, we have not poſitively determin'd the Returns of above one or two; however, it's certain, that like our *Planets*, they do move in a recurring *Orbit*, that the *Sun* is in one of the *Foci* of this *Orbit*, that by a Ray from the *Sun*, they deſcribe equal *Area*'s in equal Times, that the ſame *Law of Gravitation* obtains in them, which does in the *Planets*; that their *Periodical* Times are certain and invariable, and that their Motions are regular; only their Courſe in their *Orbits* is not determin'd one way, but indifferently ſome of 'em move one way, others another: They are alſo about the ſame Bulk with the *Planets*, generally ſpeaking; and like them are compact ſolid Bodies, but ſurrounded with a vaſtly large thin Fluid, intermixt with ſeveral groſſer Particles, and compoſing an irregular unequally diſpos'd, and uncertainly agitated Maſs; which is call'd it's *Atmoſphere*, whoſe *Diameter*, is ten or fifteen times as long as that of it's Body. Beſides which, it has a long lucid *Train*, which is rais'd in it's approach to the *Sun*, by the heat thereof, and extends ſometimes to four hundred Thouſand Miles above it's Body.

dy. It is always oppoſite to the *Sun*, becauſe it is the thinner part of it's *Atmoſphere*, extremely rarifyed by his Rays; and ſo rare that the *Stars* may be ſeen through it. This T*ail* accompanies it through it's Courſe over all the P*lanetary Regions*, encreaſing in it's Approach to the *Sun*, and leſſening in it's Receſs. And which is very obſervable, as the T*ails* decreaſe, the *Atmoſphere* is enlarged, which happens in their *Receſs* from the *Sun*, and as the T*ails* encreaſe, the *Atmoſphere* leſſens, which happens in their *Acceſs* to the *Sun*, juſt as it ſhou'd be according to this T*heory*. Theſe *Comets* ſometimes come ſo near the *Sun*, as to be heated to ſuch a Degree that they cannot become cool again, in many Thouſands of Years. Their T*ails* are broader at their *top*, than near the Body of the *Comet*; becauſe in theſe almoſt void Spaces the Vapours are more and more rarifyed and dilated: And by this perpetual Rarefaction and Dilation, theſe Vapours of the T*ails* of *Comets*, are ſpread and diſperſed through our whole *Syſtem*: And ſo are attracted by the *Gravitation* of the P*lanets*, and mixt with their *Atmoſphere*: As has been formerly ſhown; and become a ſupply of that continual decreaſe of Fluids, in the P*lanets*, which is cauſed by the continual Conſumption on Vegetation, and the

Putrifaction of theſe Fluids. And as among the *Planets*, they are the leaſt, which revolve in leaſt *Orbits* and neareſt the *Sun*: So it's not unlikely theſe *Comets*, which in their *Aphelia*, come neareſt the *Sun*, are of the leſſer ſort: That by their *Attractions*, they may not diſturb the *Sun* too much. It is not improbable, that ſome of theſe *Comets*, have viſited our *planetary Regions* oftner than once. The *Comet* that appeared in 1667, and that in 1682 had both, by computation, pretty near the ſame *Orbit*, the ſame *Aphelia*, and *Perihelia*, and the ſame Inclination of the *Plane*, of their *Orbits* to the *Plane* of the Ecliptick: And conſequently, it's not improbable, that they were both one and the ſame *Comet*. And therefore the time of it's Revolution, is about 75 Years. The reſt of the *Comets*, take up a longer time, in their Revolutions; and aſcend higher from our *Syſtem*. Beſides the *Comets* by reaſon of their great Number, the great diſtance of their *Aphelia*, from the *Sun*, and conſequently their long ſtay and ſlow Motion in theſe *Aphelia*; muſt diſturb one another, by their mutual *Gravitations*: And therefore their *Eccentricities*, and the times of their Revolutions, muſt ſometimes be encreaſed and ſometimes leſſened: And conſequently, it is not to be expected they ſhou'd conſtantly return in the ſame *Orbits*, and in the ſame *Periodical* times exactly: It's enough, the changes be not greater than may be expected from ſuch Cauſes; and from hence we may obſerve, the reaſon why the *Comets* are not contain'd in the *Zodiac*, as the *Planets* are: But direct their Courſes differently, on all Hands, and through all the Regions of the Heavens; and that is, that in their *Aphelia*, where they move the ſloweſt, they may be at the greateſt diſtances from one another: And ſo *attract* and diſturb one another the leaſt that may be. The *Comet* that appeared in 1680, approached the *Sun* nearer than a ſixth part of his *Diameter*, and by reaſon of that *Comets* great Velocity, at ſo near a diſtance, and the ſomewhat Denſity of the *Sun*'s *Atmoſphere*. It muſt have ſuffered ſome reſiſtance to it's Motion thereby, and ſo muſt have been ſomewhat retarded, and muſt have approach'd ſomewhat nearer the *Sun*, ſo that in every Revolution, approaching nearer and nearer the *Sun*, this *Comet* muſt at laſt drop into the *Sun*'s Body; as alſo this *Comet* may in his *Aphelium*, where he moves the ſloweſt, be retarded by the *Attraction* of other *Comets*; and thereby in his return, be ſwallow'd up of the *Sun*. After the ſame manner, the *fix'd Stars*, which by little and little expire in Light and Vapours and ſo are extinguiſhed, may be rekindled by *Comets* falling into them, and being recruited by this new Fewel be accounted *new Stars*. If they be not *Planets*, accompanying the neareſt *fix'd Stars*, as Mr. *Derham* conjectures.

§ XIX. Thus I have given a ſhort View of this *Syſtem* of things, as it is at preſent, and I am of Opinion it is nearer the Truth than the *antient Theories*. And now let any one ſeriouſly reflect upon the *Vaſtneſs*, *Magnificence*, *Beauty*, *Order*, and *Symmetry* of this *Scheme*, and try if he can think it the Effect of Chance, or, if he can ſo much as doubt, that ſome infinitely wiſe and powerful *Architect* has rear'd this noble *Fabrick*. But to drive the Argument farther, let us enquire a little into the particular and obvious *Deſigns* and *Contrivances* of this Divine *Architecture*. And 1. It is plain from what has been ſhewn, that the univerſal Principle of *Attraction* or *Gravitation* obtains in all the Great Bodies of this Univerſe; and that the Motions of all the *Planets*, their *Satellits* and the *Comets*, are govern'd by one Condition thereof, *viz.* that the Force thereof at different diſtances from the Center of Attraction, is *reciprocally* as the *Squares* of theſe Diſtances. Now is it at all probable that ſo *univerſal a Law*, ſo powerful a *Principle*, and ſo conſtant a Rule ſhou'd be owing to Chance? If one with 10000 Dice, ſhou'd throw 5000 Sizes, once or twice, or even 1000 Sizes once and again, we might poſſibly ſay he did it by Chance; but if with an almoſt infinite Number of Dice, he ſhou'd always without failing throw the ſame ſide in 'em all, we ſhou'd certainly conclude, he either did it by *Art* and *Contrivance*, or that theſe Dice cou'd turn up on no other ſide. Now I have demonſtrated that *Gravitation* is not *eſſential* to Matter, and ſo it might have been without it; and yet all the Bodies of the Univerſe, ſo far as we can diſcover, are endow'd with this Principle; and obſerve this one Condition of it, and therefore, both were deſign'd by him who laid the Foundations of the World. 2. It is worth our Obſervation to take Notice, how conſtant and beautiful a Proportion, the Times of the Revolutions of all the *Planets*, and their *Satellits*, keep to their *middle Diſtances*; for univerſally, in all the Revolutions of the *Planets* about the *Sun*, and of the ſecondary *Planets* about the *primary* ones, the *periodical Times* is in a *Seſquialter* Proportion to the *middle Diſtances*; or the *Cubes* of the middle Diſtances, from the Center of their Motions, are in all of them (*Planets* and *Satellits*) as the *Squares* of the *periodical Revolutions*. 3. All the *Planets* and *Comets* by Rays from the *Sun*, and all the *Satellits*, by Rays from their primary *Planets*, deſcribe equal *Area*'s in equal Times, *i. e.* the *Area*'s deſcrib'd, are always *proportional* to the Times pretty nearly. So that when they approach to the Center of their Motion, they move faſter, and when they recede from it, ſlower; ſo as to compenſat their nearneſs, by their Swiftneſs, and their Diſtance by their Slowneſs: Always making up equal *Area*'s in equal Times. Theſe two ſo *univerſal*, and ſo *regular* Affections, of the Motions of the *Celeſtial* Bodies, are not only diſcoverable by Obſervation, but are the neceſſary Effect, of the Law of Gravitation, juſt now mentioned to be the *Principle* of the Heavenly Motions. Can any Body now, who conſiders how many things are concurring to, and depending upon theſe beautiful *Proportions*, and regular Effects, ſo much as once queſtion whether they are the Product of infinite Wiſdom? Certainly nothing leſs cou'd be ſufficient, to make the *Computation*, adjuſt the *Forces*, and determine the *Powers*, neceſſary towards the Production, of ſuch exact and regular *Effects*. 4. All the *Planets* are ſo wiſely ſituated, in reſpect of the *Sun*, that the denſer *Planet*, is ſtill neareſt him, and the leſs Denſe, is fartheſt remov'd from him; and the leaſt Denſe of all, is the moſt remote. Now can any Body think this was ſo ordered without *Deſign*? No certainly, it is ſo obvious no Body can miſs of it; for it is plain the more Denſe Matter requires a greater Degree of Heat, to fit it for natural Productions; and the leſs Denſe, needs only a leſſer Degree of Heat, for the ſame End. And conſequently, their Diſtances were adjuſted for this very Reaſon; and this by the by, is a Preſumption for the *Planets* being inhabited, ſince according to their Denſities, they are fitted with Degrees of Heat neceſſary for natural Productions: Now this Adjuſtment and theſe natural Productions were uſeleſs, if there were no Creatures to enjoy the Benefit of 'em; and we all know Nature has done nothing in vain. And therefore ſince theſe *Accommodations* are provided for living Creatures, there are ſuch probably to enjoy 'em. 5. The *Velocity* of the *Planets* Motions, is ſo adjuſted in reſpect of the *Sun*, and the *Velocity* of the *Satellits*, in reſpect of their *primary Planets*, that the *Planet* which is neareſt the *Sun*, moves faſteſt, and thoſe more remote, leſs faſt, and the fartheſt, ſloweſt of all. And ſo in the *Satellits*; the neareſt to the *primary Planets*, moves quickeſt, and the remoteſt, ſloweſt. For ſince the *Centripetal* Forces, are *reciprocally*, as the *Squares* of the *Diſtances* from the Center, and the *Celerities*

lerities in that caſe, reciprocally, as the *ſquare Roots* of the Diſtances from the Center; and ſince the ſquare Root of the remoter Diſtance is greater, than the ſquare Root of the nearer, therefore the Velocity of the nearer, is greater than that of the remoter. Now this is a wiſe *Contrivance* of the *Author* of *Nature*; for ſince the nearer P*lanet* enjoys more of the Heat of the *Sun*, than the remoter, it was fit the Viciſſitudes of the Seaſons, ſhou'd be quicker, that anſwering beſt the Ends of natural Productions; for ſince their Diſtances are leaſt, and their Velocities greateſt, that are next the *Sun*, their P*eriods* muſt be ſhorteſt; and ſince they all move about their *Axes*, moſt, if not all of them, making thereby ſome *Angle* or other with the Plane of their *Orbit*, they muſt admit of variety of Seaſons; and where the Heat is greateſt, there for the conveniency of natural Production, it was neceſſary the Seaſons ſhou'd be ſhorteſt, where the Heat is leaſt, there the Seaſons ſhou'd be longeſt: Now all theſe Effects are taken care of by this adjuſting of the Velocity to the Diſtance. And what is here ſaid of the Seaſons in reſpect of the *Planets*, may be underſtood of the *Satellits* Influences, from their *primary Planets*; for whatever Effects the *primary Planets* produce on the *ſecondary* ones, it is doubtleſs moſt convenient, the Viciſſitudes thereof ſhou'd be quickeſt, in the neareſt, and ſloweſt in the remoteſt *Satellits.* And this, as well as the former, is a ſhrew'd Preſumption of the *Planets* being inhabited; for all this beautiful Contrivance is loſt, if there be no Inhabitant in the *Celeſtial* Bodies to enjoy the Benefit of it. 6. All the *Planets*, deſcribe about the *Sun* in one of their *Foci*, *Elliptick Orbits* of one Species or another; and all the *Satellits* deſcribe about their *primary Planets* in one of their *Foci*, *Elliptick Orbits* alſo; and the Planes of all the Orbits do very nearly coincide with one another, and with the Plane of the *Ecliptick.* That the *Planets* deſcribe *Elliptick Orbits* about the *Sun*, there is no manner of doubt now among *Aſtronomers.* And tho' they ſay, that the *Orbits* of the *Satellits* are not exactly *Elliptical*, yet that is from neceſſary Cauſes, and is not owing to Chance, but to the already eſtabliſh'd Laws of the Univerſe; yet ſtill their *Orbits* are nearer *Ellipſes* than any other *Geometrical Curves*, and may be reduc'd to theſe; and that the Planes of the *Orbits* of the *Planets* coincide with the Plane of the *Ecliptick*, and with one another nearly, is matter of Obſervation. Now is it imaginable, this beautiful and conſtant Order of theſe three things, of *Elliptick Orbits*, the Situation of the *Sun* in the one of the *Foci*, and the Coincidence of the Planes, of the *Orbits*, with that of the *Ecliptick*, cou'd have been the Effect of Chance and Caſualty? Or that it was without Deſign or Counſel? No certainly, for the Advantages thereby ariſing to our *Earth* in particular, are evident; for thereby, the colder and more Northern Places of our Globe, are brought ſome hundreds of thouſand Miles, nearer the *Sun* in Winter than in Summer; which cannot but be of ſome ſmall uſe to thoſe Places, that by the natural Courſe of the Earth, are depriv'd of the benign Influence of the *Sun* at that Seaſon. Now this Benefit wou'd be conſtant if the Place of the *Perihelium* did not change; but ſince that is not conſtant, the other is not durable, but temporary. But this change is not now to be taken notice of, ſince it is a Queſtion if theſe Irregularities were any part of the firſt Contrivance of this Univerſe. Now tho' in the reſt of the *Planets*, the Situation of their *Perihelia*, is not the ſame; yet nothing is to be concluded from thence, againſt this Argument, ſince we know not the Nature of their Inhabitants, nor of their natural Productions: But this we may conclude, ſince it is of notable Uſe to one of the *Planets*, it cannot be amiſs to any of 'em, they agreeing in moſt things: But whatever be the Deſign thereof, yet the conſtant Order of theſe things are a ſufficient Proof that they were not Caſual, but the Work of infinite Wiſdom. 7. The *Sun*, all the *Planets*, and their *Satellits*, ſo far as we have had occaſion to know, move about their own *Axes*, the *Axe* of this Rotation is always *parallel* to itſelf, and they revolve all one way from Weſt to Eaſt, and that in Planes, almoſt coincident with one another, and that of the *Ecliptick*. As to the *Rotation* about their own *Axe*, it is matter of Obſervation in the *Sun*, the *Earth*, *Mars*, *Jupiter*, *Venus*, the *Moon*, and it is very probable in the other two; and as to the *Paralleliſm* of the *Axe* of their Rotation, it is demonſtrable *à priori*, as I have formerly ſhewn, and wou'd be nicely exact, if the ſame were not diſturb'd by ſome collateral Cauſes; as alſo the Coincidence of the Planes of this Rotation, with one another, and with the Plane of the *Ecliptick*, is ſo very near the Truth, that the ſmall Difference from it, is not to be regarded. Now can theſe conſtant and regular Effects be aſcrib'd to any thing, but an over-ruling Providence? Can Jumble, and Confuſion produce regular and invariable Effects? It is altogether impoſſible, and therefore, nothing but the Author of Light, and Order, and Beauty, cou'd have brought about ſo uniform, and ſuch conſtant Effects. Farther, let us now conſider, that all theſe beautiful and comely *Proportions*, all theſe conſtant and immutable *Effects*, all theſe uniform and regular Appearances, which agree, not to a few things, or in ſome particulars, but in moſt of them, to all the *Planets*, to all their *Satellits*, to the *Sun*, and the *Moon*, and the *Comets*, and in a Word, to every thing in this our *Syſtem*, might have been varied, ſeveral and diverſe ways; and yet none of 'em wou'd have fitted ſo well, to the preſent ſtate of things, and the univerſal Benefit of the whole *Syſtem*, as theſe already ſettled. Thus there might have been an *infinity* of different, poſſible Laws of *Gravitation*, yet none of them wou'd have fitted our preſent Circumſtances, ſo well as the *Reciprocal Duplicat*. There are innumerable *proportions*, beſides the *Seſquialter*, yet none of 'em had ſuited us ſo well, becauſe this is the Effect of the Law of Gravitation, and on theſe two, all the ſubſequent Advantages from the preſent eſtabliſh'd Motions of the *Planets* depending, any other different from theſe wou'd have depriv'd us of thoſe Advantages. The various poſſible Diſtances of the *Planets* from the *Sun*, the poſſible Times of their *Revolutions*, their poſſible *Celerities*, the poſſible *Figures* of their *Orbits*, and of the *Inclinations* of their

Planes to one another, and to the Plane of the *Ecliptick*, their poſſible *Denſities* and *Bulks*, and the poſſible *Changes* of their many other *Affections*, are in number infinite; and yet I have ſhewn that moſt of theſe as they are at preſent, bring very conſiderable Advantages with them, to the *Syſtem* in general, which conſequently wou'd be loſt, were they diſpos'd after another manner. Add to theſe, that all theſe Affections of the *Heavenly Bodies*, might have been in no regular Order, nor conſtant Proportion, at all, and conſequently the poſſible Varieties of the *Celeſtial Bodies* might have been infinite among themſelves, and different from thoſe now mentioned. But ſeeing every thing is adjuſted by *Number*, *Weight*, and *Meaſure*, ſeeing they obſerve *Order* and *Proportion*, and that every one of 'em is diſpos'd in the fitteſt *Order*, the preſent ſtate of things will admit, ſince both the whole and the ſeveral Parts of the *Celeſtial Fabrick*, is both very good, uſeful, and convenient, who that conſiders all theſe things, dares ſo much as doubt whether he who did all theſe things *lives and reigns for ever and ever?* Or who can forbear to admire and adore him, who *weigh'd the Mountains in Scales, and the Hills in a Balance, who ſtretch'd the Heavens like a Curtain*, and held the Earth in his Hands, *whoſe right hand*,

hand, and *ſtrong Arm does wonderful things paſt finding out.*

§ XX. Having now conſidered, ſome of the more general Affections, of the *Heavenly Bodies*, and of their Motions, and ſhewn ſome of the Advantages, ariſing from their preſent Order and Diſpoſition. I come now to conſider the *Celeſtial Bodies* a little more particularly, and firſt as to the *fix'd Stars*, can any thing beget a greater *Idea* of the Univerſe, or of it's Creator, than that *prodigious* number of glorious Bodies, like our *Sun*, rang'd all up and down the *immenſe Vaſt*, and remov'd at Diſtances from one another anſwerable to their Diſtance from us? This, not only their different *apparent Magnitudes*, but likewiſe the number of thoſe of the firſt, and ſecond Rate, does evince. For upon the Suppoſition, that every *fix'd Star*, is like our *Sun*, and governs in a Portion of *Mundan ſpace*, equal to our *Syſtem*, then there muſt be only as many *fix'd Stars* of the firſt Magnitude, as there are *Syſtems* that can ſtand round ours; but there are but about twelve or thirteen *Spheres*, that can ſtand round a middle one, equal to 'em; and ſo many are the *Stars* of the firſt Magnitude. Again, if we examine how many *Spheres* can ſtand round this firſt Range of *Spheres* we will find their number betwixt forty eight and fifty two, and ſo we find the number of the *Stars* of the ſecond Magnitude. As for the ſeveral other Magnitudes, it is not altogether poſſible to determine their number, becauſe they are not ſo diſtinguiſhable from thoſe of the other Magnitudes, as the firſt and ſecond are. Beſides, I do not plead here for Accuracy, but only for things being nearly ſo; for, I do not think that the *fix'd Stars*, are either all of the ſame real Magnitude, or that their *Syſtems*, are all of the ſame Dimenſions: Theſe things being nearer any regular Proportion, than they are to Irregularity, is ſufficient for my Purpoſe; for it is impoſſible for any Body, ſeriouſly to conſider in his Mind, or view with his Eyes, what is certain about theſe glorious Bodies, to hinder himſelf from being raviſh'd with the Power and Wiſdom of the *Great God of Heaven and Earth.*

§ XXI. How *beautiful* and *glorious* a Body is the *Sun*, and of what abſolute Neceſſity to the Being of all *Animals* and *Vegetables!* As to *Vegetables*, it is beyond all doubt, that without him they cou'd never riſe above the Ground; for it is his Heat alone, that rarifies the ſizy vegetable Juices about their tender Roots, and makes them force their way, to diſplay all the Foldings of the ſlender Seed, and thereby to augment their Parts; juſt as we find his

Heat, raiſes the Liquor in the *Thermometrical* Tubes, and drives them through all it's winding Branches, and tho' perhaps *Animals*, might make a ſorry Shift (ſuppoſing Food cou'd be ſupply'd 'em without his Influence) in a perpetual State of Darkneſs, yet it wou'd be a very miſerable ſort of Life, and cou'd be of no long continuance; for we know, how neceſſary the *Sun* is to purify our Air, and to exhale the *noxious* Dews, and the baleful Vapours of the Night; we feel a ſenſible Joy in his Light, and Heavineſs in his Abſence; foul Weather, and a cloudy Day, is a Diſeaſe alone, and he who underſtands the *Animal Oeconomy*, knows the Reaſons, and the *Mechanical* Neceſſity of all theſe things, One thing ev'ry Body knows, *viz.* that by the Heat of the *Sun*, and the Action of his Rays, the Circulation is promoted and that infinite Number of the *excretory Ducts* of Perſpiration, plac'd along all the ſuperficial Parts of the Body are open'd, and enlarg'd, and ſo thoſe Exhalations, which Nature has deſign'd ſhou'd be carry'd out of the Body, are more freely and plentifully deriv'd; which muſt needs give a greater Freedom to the Blood and Spirits, the contrary of all which, happens in the Abſence of this *Benign Star*. But of this more afterwards. It's being ſituated immoveable in the Center of our *Syſtem*, no Body who has been at the pains to conſider the Matter, I believe doubts now, for not to mention at preſent the Controverſy about the *Parallax* of ſome of the *fix'd* *Stars*, which Mr. *Flamſted* has obſerv'd, and whereby he pretends to demonſtrate the Motion of the Earth, and conſequently the Stability of the *Sun*; there are ſome other Arguments that will have ſufficient Weight to ſettle the Matter among thoughtful Men. For 1. It is altogether impoſſible to account for the Appearances of the *Planets*, their *Satellits*, and of the *fix'd Stars*, in any tolerable manner, without admitting the Motion of the Earth. 2. It is likewiſe impoſſible to account for the Motions of the *Comets*, upon any other Suppoſition. And 3. that Analogy of the *Periodical* Times, to the *middle Diſtances*, which is the neceſſary Conſequence of the eſtabliſh'd Law of Gravitation, does demonſtrate the Earth's Motion *à priori*; ſo that unleſs we wou'd ſubvert the whole *Syſtem* of *Aſtronomy*, and diſprove the Cauſes of all the Celeſtial Motions, we ſhall never be able to prove the Stability of the *Earth*. For if the Celeſtial Bodies attract one another in a *duplicate Proportion reciprocally*, to their Diſtances from the Center of their Revolutions, then the *Earth* (and not the *Sun*) moves. Add to all theſe, that there is no tolerable Objection againſt the Earth's Motion, but has had a full Anſwer, and a plain Solution. Now what an Inſtance of Wiſdom and Contrivance is this, in placing that Fountain of Light and Life, in the Center of his *Syſtem.* How unartful wou'd it have been, to have ſet him in a Corner, when he was to have giv'n Light and Warmth to all the Bodies round him; beſides, to the conſervation of any ſuch Suppoſition (ſuch as the *Tychonick* or *Ptolomiack*) there are requir'd ſo many different Laws of *Gravitation*, that any reaſonable Perſon by inquiring into them, wou'd eaſily diſcover, that whatſoever was Matter of Fact, yet this Poſition of ours was the moſt ſimple and eaſy, and look'd moſt like the Effects of Wiſdom and Deſign: For here one ſingle Law, accounts for all the various Motions and Appearances of the *Celeſtial Bodies.* Thus then this great and glorious Body is fix'd, like a powerful and a kindly *Monarch* on his Throne, diſtributing Light, Warmth, and Life in plentiful Effuſion, to all his ſurrounding *Vaſſals*, and that ſo equally, that the neareſt have not too much, nor the remoteſt too little. Theſe are ſuch great, ſuch wiſe Ends, as clearly ſpeak the *Omnipotence* and *Omniſcience* of their *Author.* Moreover, let us conſider, with how much Artfulneſs his Bulk and Situation, in reſpect of the *Planets*, is contriv'd, to have juſt Quantity enough of Matter to draw round him theſe Maſſy Bodies, and their *Satellits*, ſo various in their Bulks and Diſtances from him; and that in regular and uniform *Orbits*. How exactly his Body is rounded, how fully it has been ſaturated with the Fluid of Light, to be able to laſt ſo many Years without any ſenſible Diminution, tho' there are conſtant Emanations thereof upon his Attendents. As for his *Rotation* about his own *Axe*, it is no doubt likewiſe, for wiſe Ends and Purpoſes, perhaps it may be for the better propagating, and emitting this Fluid of Light, through the *Planetary Regions*, or for helping forward the Revolutions of the Planets in their Orbits round about him.

§ XXII. We can no otherwiſe gather the uſefulneſs of the *ſecondary Planets*, to their *primary* ones, but by ſuppoſing the reſt may reap *reſpectively*, ſome thing *analogous*, to the Benefits we of the Earth, receives from our *Moon*, which are 1. The ſupplying of the *Sun* in the Night time, for at leaſt three fourths of the Year. Now how comfortable and delightful a thing this is, Travellers and Voyagers can beſt tell, *Curioſity*, *Ambition*, and *Luxury*, if not ſometimes *Neceſſity*, have now made it unavoidable, that ſome part of Mankind ſhou'd be travelling by Land or Sea, in the Night Seaſons; how pleaſant then, and joyful a thing, is it to have a Light held us forth from *Heaven*, not only to guide our Steps, but to direct us in our Courſe, and to point out to us, how our time wears out? For a very little Experience, makes us reap both theſe laſt Advantages from the Preſence and Motion of the *Moon*. 2. She raiſes our *Tides*, twice in twenty four Hours, which how abſolutely neceſſary that is toward the ſubſiſtance of *Animals* and *Vegetables*, we ſhall now ſhew. Every Body knows that a *Lake* or *Loch*, that has no freſh Water running into it, will by the heat of a few Months, and it's Stagnation, turn into a ſtinking rotten *Puddle*, ſending forth nauſeous and poyſonous Steams; for tho' I do not think, the conſtituent Particles of Water themſelves, are alter'd by this Stagnation, yet no Water is abſolutely pure, but contains a greater Quantity of Fleſhy, Bony, Earthy, Salin, Metallick, and Vegetable Particles, than of pure *Element*; and it is upon theſe, the heat operates, by diſſolving their Union, and combining them in new Forms, and ſeparating theſe *Salin*, *Sulphurous*, and other *noxious* Particles which produce this Effect. Now tho' there be many thouſands of freſh Water Rivers, daily running into the *Sea*, yet they are very inconſiderable in reſpect of the *vaſt Ocean* of Salt Water, and wou'd by no means hinder it's Stagnation, and conſequently it's Corruption and Stinking. But admit the Ocean once ſtagnated, and then the firſt Effect wou'd be, that all the Places toward the Shores, wou'd be firſt wrought upon by the Action of the *Sun*, and turn'd to a *Memphitis*, and then by Degrees it wou'd get farther, till the whole were become more *baneful* and *poyſonous* than the Lake of *Sodom* and *Gomorrah*; whereby the *Fiſhes* wou'd be firſt deſtroy'd, and by the noxious Steams thence ariſing, afterwards the *Plants* and *Animals*; whereas by this Action of the *Moon*, the Waters are lifted up in a heap, as it were, and then let fall again; whereby the Waters near the Shores, are conſtantly ſecur'd from Stagnation and Corruption, and the beginning Malady ſtifled. This perpetual Change of new Water on the Shores, keeping any one Portion thereof, too ſhort a time, expos'd to the heat of the *Sun*, to have it's mixture corrupted. Now what a *noble* Contrivance have we here! by appointing an *Attendant* to our *Earth*, all the *Vegetables* and *Animals* are preſerv'd from certain Deſtruction; (but I am of opinion that to the full effect of this wiſe Deſign, the Salt of the Sea does very much contribute; for as I have ſaid before, and may obſerve afterward, the pointed ſlender Particles of the *Salt*, ſtick the Parts of Bodies ſo together, that the Particles of Heat, cannot ſo eaſily tear 'em aſunder, and it is *Fact*, and *Obſervation*, that there are many ſalin Rocks and Mountains diſperſed over the Foundations, of the Great *Ocean*.) Beſides this, how many Conveniencies for our *Navigation*, in Rivers and Harbours, does this ebbing and flowing of the *Sea* afford? No Body that conſiders them, can ceaſe from Wonder, or can continue in Unbelief. And here perhaps it will not be amiſs to conſider, that if our *Earth* had any more than one *Moon* attending it, that we ſhou'd receive more Damage than Advantage from it; for tho' perhaps thereby our Light in the Night (provided ſhe were of any Bulk, or at any Diſtance near to that of our preſent *Moon*) might be augmented, yet at the *Conjunctions* and *Oppoſitions* with one another, and with the *Sun*, we ſhou'd have Tides that wou'd raiſe the Waters over too much of our dry Land, and in their *Quadratures*, we ſhou'd have no Tide at all. In ſhort, if our *Moon* were bigger or nearer the *Earth*, or if we had more than one, at any tolerable diſtance from us, we ſhou'd be every now and then, in hazard of being drown'd; and if our preſent *Moon* were leſs, or at a greater diſtance, or if there were none at all, we ſhou'd be in hazard of being ſtifled by the noxious Steams ariſing from the *Ocean*, which wou'd ſtagnate more than it now does. From all which it's evident how wiſely our *Satellit*, has been contriv'd for our Purpoſes. As for the numerous Attendants of *Jupiter* and *Saturn*, they muſt be reaſonably expected to fit the Neceſſities of the Inhabitants of theſe *Planets*, ſince our Moon ſuits us ſo well. As to *Jupiter*, conſidering his Bulk and Diſtance from the *Sun*, being near 400 times bigger than our *Earth*, and receiving but a twenty fifth Part of our Heat: In what a diſmal State of Cold and Darkneſs eſpecially, wou'd he be in? Were it not for his *Moons* or *Satellits*, and for his Rotation about his *Axe*, in about *Ten Hours*: Whereby the little Vigor of his Light and Heat is compenſated, by its quick Returns. His *Satellits* being each of them as big as our *Earth*, and reflecting in upon *Him* ſo ſtrong, briſk, and vivid a Light, as they do: And their *Revolutions* being ſo adjuſted, as may be ſeen, in the *Table of them in the beginning of this Chapter*: It thereby happens, that ſcarce any Part of this *Planet* is any time without the preſence and influence of ſome one or more of theſe *friendly Attendants*. So that by this numerous Retinue, their ſtrong Light, the encreaſing *Periods* of their Revolutions, as they are diſtant from him, and his quick Motion about his *Axe*: His Light and Heat are wonderfully encreas'd, from what they wou'd be without theſe Contrivances and Adjuſtments. But that which is the fineſt Contrivance of all, in theſe *Satellits* is (as Mr. *Derham* has obſerved,) in their Latitudes, or their Evagation towards *Jupiter*'s Poles, the Latitude of the innermoſt being $\frac{1}{3}$ of *Jupiter*'s *Diameter*, of the next $\frac{1}{4}$, the third $\frac{3}{4}$ and the laſt going beyond *Jupiter*'s *Poles*, one third part of his *Diameter*: And as their *Latitudes* differ according to their Diſtances, and Periods, ſo they change their *Latitudes* in ſhorter or longer times according to their leſſer or greater *Latitudes*, ſome making their Progreſs towards his *Poles* one way, whilſt ſome are wandering the other, ſome ſtaying there a longer time, and ſome a leſſer and a leſſer time, by which quadruple variety, thoſe large Tracts towards the polar parts of this huge *Planet*, have a conſtant and yet various ſhare in the Light and kindly Influences of theſe four *Moons*, and are ſcarce ever depriv'd of one or other of them. As to *Saturn* as he is yet farther from the *Sun*, than *Jupiter*, and has but the hundredth part of our Heat, he is accordingly provided with more *Satellits* (at leaſt five if not more,) adjuſted much after the ſame manner, and appointed for the ſame ends and purpoſes with thoſe of *Jupiter*, we have now deſcrib'd. But he has ſtill a further proviſion made for *him*, and that is his *Ring* the moſt ſurprizing and ſingular Appearance in all the *Celeſtial* Regions: It's ſize is prodigious, being more than twice as broad in *Diameter*, than *Saturn* is: And the breadth of the *Ring* it ſelf about a fourth part of *Saturn*'s *Diameter*: And *it's* diſtance from *his* Body about the ſame length, whereby the *Sun*'s Heat and Light has a free admittance between the *Planet* and its *Ring*, while other Heat and Light is at the ſame time reflected in upon it, by this *Ring*. Its thickneſs is ſcarce perceiveable, which prevents its throwing any great Shadow on *Saturn*. But its ſmoothneſs and reflecting faculty, is very conſiderable, as is evident from the exceeding Brightneſs and Illuſtration it reverberates on its *Planet*: So that it ſeems not unlikely, that it may be a kind of *ſpecular* Contrivance, for reflecting Heat and Light on its central Sovereign, in his great diſtance from the ſource of Light and Heat. And very probably *Saturn*'s Period, on his *Axe*, or diurnal Rotation, may be pretty quick, and his Inclination to the Plane of his *Ring*, or Plane of his *Orbit* pretty large, as it is in *Jupiter*, to make all theſe wiſe Proviſions and Accommodation perfect and compleat. But further we may obſerve one very ſignal Inſtance of *Wiſdom* and *Contrivance*, in placing the Heavenly Bodies at ſuch a Diſtance from each other, and eſpecially the greateſt at the greateſt Diſtance; for had they been ſituated much nearer to one another, they wou'd have caus'd prodigious Diſorders in very different Manners, and in particular ſuch deſtructive *Tides*, wherever there was any Quantity of Fluids, or great *Oceans*, that neither *Animals* nor *Vegetables* wou'd have been able to ſuſtain their Fury; which by this prudent placing the *Heavenly Bodies*, at ſuch a Diſtance from one another, are intirely prevented. 3. From our *Moon* the *Eclipſes* call'd by her Name proceed, which is of exceeding uſe in *Navigation*; for by them the Differences of *Meridians*, and the *Longitudes* of Places are determin'd. Of the ſame uſe are the *Eclipſes* of the *Sun*, and of the *Satellits* of the other *Planets*; which laſt being ſo frequent, are of wonderful Aſſiſtance, toward the Solution of this ſo deſirable and ſo much deſiderated *Problem*. And upon this Head of *Navigation* all *Aſtronomy* comes in, without which the other were meer groping in the Dark; but the World is already ſo ſenſible of the Advantages ariſing from the Motions and Appearances of the *Heavenly Bodies*, in the Matter of *Navigation*, that I ſhall inſiſt no farther on this

Topick, neither ſhall I mention, the probable Influence the *Moon* has on *Vegetables*, *irrational* or *rational Animals*: The laſt having been fully canvaſs'd, in that *curious Treatiſe* of the *Accurate* and *Learned* Dr. *Mead* in his Book *de Imperio Solis & Lunæ in Corpora Humana*, but from this whole Section about the uſe of the *Attendants* of the *Planets* ſhall infer, that they are not mute Perſons, in this great *Drama* of the World, but loudly proclaim the *Wiſdom* and *Being* of their *Author*.

§ XXIII. As to the *Comets*, I have little more to ſay about them, than what I have already ſaid, their *Natures*, *Orbits*, *Motions*, and *Situations*, have been ſo lately determin'd, (indeed it is but of late, that the *Aſtronomy* of the *Planets* themſelves, and their *Satellits* has been brought to any tolerable Perfection, and much later ſince final Cauſes have been cultivated, with Care becoming ſo noble and uſeful a Part of *Philoſophy*;) and there are ſo few accurate Obſervations about 'em extant, ſo few of 'em, that we know of, have viſited us twice, that we have ſcarce any ſolid Foundation to build our Reaſoning upon; all I think can be rely'd on is, that they are ſolid Bodies like our *Planets*, that like them they move in regular very oblong *Elliptick* Orbits, in one of whoſe Centers or *Foci* the *Sun* is placed. That they do revolve by the ſame Virtue of *Gravity*, and by the ſame Law thereof, as theſe do. That their *Train* is raiſed by the Heat of the *Sun* as they deſcend toward him in their *Perihelium*, ſeeing it encreaſes in it's deſcent towards the *Sun*, and leſſens in its aſcent from him. That this *Train* is only the more Fluid part of its *Atmoſphere* extremely rarifyed. That ſome one or more have return'd in the ſame Orbits and with the other determining Circumſtances, pretty nearly, whereby it is render'd probable that theſe were one and the ſame, only in different Revolutions. And if the uſes aſſign'd to them by Sir *Iſaac Newton* be real, as they are not improbable, to wit, the ſupplying the Deficiency and Expences of all the ſorts of Fluids neceſſary or uſeful to our *Syſtem* in general, and to our *Globe* in particular. I mean not only Light and Heat to the *Sun* and *fix'd Stars*, Water and watery Vapours, to our *Atmoſphere*, but the moſt ſubtile, moſt uſeful, and neceſſary part (towards Life and Vegetation) of our Air to that *Elaſtick* Fluid. And very probable, other Advantages *Analogous* to theſe they bring to our *Earth*, and ſuited to their particular Wants, to the other *Planets* and their *Satellits*. If, I ſay, theſe uſes aſſign'd to them, and juſtly riſing from their Natures, and the known *Analogy* of Things, be real, then theſe wandring frightful Bodies may be juſtly concluded joyning in the *Chorus* and loudly reſounding the ſame *Allelujah.*

§ XXIV. Come we now to enquire into the Wiſdom of the Contrivance of the *Planets.* But having already ſhewn the *Analogy* between them and our *Earth*, and how probable it is that they are inhabited by Creatures fitted for ſuch Habitations, I ſhall content my ſelf with pointing out ſome of the moſt conſiderable Inſtances of *Deſign* and *Wiſdom* in this our *Planet*; hoping the Reader will reaſon after the ſame manner (bating particular Circumſtances) of the reſt, and that, both becauſe the deſign'd Brevity of this Treatiſe will not permit me to be ſo particular, as the Subject deſerves, and becauſe, if the *Analogy* hold in general, the particular ones (with allowance for Circumſtances) will eaſily follow. And firſt let us conſider the Advantages, ariſing to us by the *Rotation* of the *Earth* about its own *Axis.* We the Inhabitants of this Globe are ſo made, that once in ſixteen or twenty Hours at moſt, we require a time for *Relaxation*, and generally ſpeaking, in all healthful People this time is pretty equal, between ſix and nine Hours, the Store-houſes of our Spirits will not permit any longer Application than twenty Hours, without Injury to our Conſtitutions, and much about the time of ſix Hours is requir'd to fill 'em again; and generally ſpeaking, it is neceſſary that an Alternation of *Application* and *Relaxation*, ſhou'd be once in twenty four Hours. It's true Cuſtom and Education, may get the better of theſe *natural Propenſities*, and a very ſtrong Conſtitution may bear out with harder Meaſures for ſome time; but the Young, and the Weak, and almoſt all at their own Liberty, naturally run into a *Relaxation*, and recruiting their Spirit by Sleep, once in twenty four Hours. It was likewiſe neceſſary, that the Air ſhou'd be at leaſt cool and temperate, during the time of this Reſt, for we generally find thoſe that ſleep in the open Air, or ev'n while the *Sun* is above the *Horizon*, the worſe for it; the *Sun* and Heat exhaling the natural Perſpirations too violently, while they are crude (hence it comes that People generally Sweat moſt who Sleep in the day time) and raiſing too quick a Motion, in the Blood, whereby the Sleep is leſs calm, and more diſturb'd. And tho' we generally perſpire more in the Night than the Day, yet the Perſpiration is leſs crude, more natural, and leſs violent, and more according to the Neceſſities of our Conſtitution, in the Night than the Day. Beſides, that of neceſſity, the Darkneſs is leſs ſubject to Noiſe and Diſturbance, than the Day. Now all theſe things are wonderfully provided for by the *Rotation* of the *Earth* about its *Axis*; for thereby we have the *Viciſſitudes* of Day and Night, the Day for *Application* and ſpending our Spirits in about the neceſſities of Life, the Night by its Coldneſs and Quiet, to afford us time to recruit 'em, and lay up in ſtore, for the Expences of the next Day; as alſo for nouriſhing the Muſcles, Bones, Channels, and the other Parts of the Body; for the Buſineſs of Nutrition is moſtly, if not altogether perform'd in the time of Reſt, becauſe the Blood has too rapid and quick a Motion, the Expences of the Spirits are too great, to afford Leiſure, or Materials for nouriſhing the Parts in the time of Application: Beſides that a gentle uniform Motion is requir'd to apply nouriſhing Parts, to the neceſſary Places, and to ſettle 'em there; and we generally find that People recovering from a Diſeaſe, and Children, ſleep more, and are more fed by their Sleep, than by any other *Animal Function*, and groſs People naturally Sleep longeſt. Likewiſe, what a comfortable and refreſhing thing is the cool Breezes of the Night, the *Trade-winds*, to thoſe that live under the *equatorial Parts*, without which Life wou'd be both exceeding ſhort, and very grievous. As to theſe *Trade-winds*, they are the neceſſary effect of the *Rotation* of the *Earth* about its *Axe*, which under the *Line* makes the Rays of the Sun direct and equal all the Year round, ſo that theſe parts being conſtantly under the *Sun*'s Influence, his Heat rarifies one part of the Air, and the cooler and heavier part preſſes upon the hotter, and ſo makes a continual Wind in his Courſe from *Eaſt* to *Weſt* under the *Tropicks*, which is both of great uſe in *Navigation*, and of great Comfort to the Inhabitants of that ſcorched Climate. Moreover, let us reflect upon the Neceſſities of our *Vegetables*, which are the ſupport of Animals; we have before ſaid, that the Heat of the *Sun* rarifies, and conſequently raiſes the ſizy vegetable Juices, at the Roots of the tender Seeds, and thereby forces the folded Branches to expand and enlarge. Now were the *Sun* conſtantly, or for any long time, ſhining upon them; theſe Juices wou'd not be at liberty to ſettle, and conſolidate in the fit Places of the Branches; but wou'd be ſtill riſing higher and higher, till at laſt they burſt the Canals, (if Vegetable Fluids were conſtantly ſupplyed to them) and conſequently cou'd produce nothing; whereas by this *Viciſſitude* of Heat and Cold, what is rais'd in the Day-time, has time to ſettle and conſolidate in the Night, and it's Cold runs the thin

Juices firſt into thick, ſizy, Subſtances, which the ſupervening Heat, by exhaling the watery Parts (which are now brought nearer the Surface of the *Plant*) does harden and fix. This we evidently ſee in *Nutgals*, and the other Excreſcences of the Leaves of *Vegetables*; and generally, Countries that have moderately cool Nights, produce *Vegetables* of the firmeſt Union of Parts; and very hot Countries, ſuddenly bring up their Seeds, but their Parts are leſs firmly ſtuck together; they may be heavier, but not ſo tough or hard, tho' this too depends much upon the Conſtitution, and firſt make of the Seed. On the other Hand, had not the Earth mov'd upon its *Axe*, but only turn'd round the *Sun* in its *annual Period*, we had not only loſt all theſe Advantages, which are ſo beneficial, if not abſolutely neceſſary to the Being of our *Animals* and *Vegetables*, but we had ſuffered alſo ſuch Inconveniencies, as neither of theſe cou'd poſſibly bear; for then, for very near one half of the Year we ſhou'd have been in perpetual Darkneſs; the Conſequence of which wou'd have been, that firſt baleful and *ſulphurous* Damps (by the Forces of the preceding Heat generated and rais'd,) wou'd have fall'n, which wou'd have ſtifled all the *Animals*, or had they ſurviv'd that, by Degrees, exceeding Rains wou'd have been pour'd down (as the Vapours became cooler) next Sleet, then Snow, and Ice, and Froſt, which wou'd of neceſſity, not only have lock'd up all Fluids, but wou'd have freez'd the Blood and Spirits in the Channels, of all the *Animals* we are acquainted with; for as I have ſhewn before, there is a ſaline Body conſtantly ſwimming in our Air, which by the Preſence and Action of the *Sun*, is ſo attenuated and reduc'd into ſo ſlender Particles, whoſe Points (being eaſieſt broken) by the Force of the Fluid of Light are firſt beat off, as not to be able to do any Dammage: But in *his* Abſence, they ſhoot themſelves into oblong ſharp Wedges, which ſtick together the Parts of all Bodies. Now in a half Years Abſence of the *Sun*, in what Quantities, and with how much firmneſs wou'd theſe ſaline Bodies have form'd themſelves! Certainly nothing that moves, whether *Animate* or *Inanimate*, wou'd have been able to ſupport ſuch a cold. And all this is not only demonſtrable *à priori*, but is Matter of Fact, and actually happens in thoſe Places that are under the *Poles*, during a much ſhorter Abſence of this *glorious Star*. Again, in the enlightned half of the Year, we ſhou'd have had, firſt huge Deluges of melted Waters, from the preceeding Snow, which likewiſe wou'd have produc'd ſuffocating Miſts; next all our Ground, wou'd have turn'd into a ſtiff ſtinking *Puddle*, (being in a manner diſſolv'd by the Force and Quantity of the Snow Water) then wou'd *Sultry Heats* and a burning Air have ſcorched and chapp'd the Earth and gall'd the animal Tribes, that they ſhou'd have found reſt, neither in Houſes nor Dens; 'till at laſt the Heat encreaſing without Abatement, the Blood and Spirits of all the *Animals* of our *Globe*, wou'd be quite exhal'd, or they turn'd delirous by the violent Agitation of the Blood and Spirits, and then dy'd in *Convulſions*, like ſo many Puppies in the *Dog-Days*; for it were abſolutely impoſſible, that any thing that has Life ſhou'd reſiſt ſuch a Degree of Heat. It's true, there are ſome People live under the *Æquator*, yet they have but an uncomfortable time on't, tho' they are ſupply'd with conſtant Breezes and Trade-winds, ariſing from the *Earth*'s *Rotation* about her *Axis*, and prodigious Quantities of Rain, falling by the Plenty of Vapours, rais'd by the Days Heat, and let fall by the ſupervening Cold of the Night, having as long a Night as they have a Day, which is a mighty Relief, the continued uninterrupted Action of *Sun*, being by much a far harder part, than the Degree of the Heat at ſtated Seaſons. And as for the *Poles*, we have very certain Information, that few if any at all, inhabit near 'em. The extreme Degrees of Heat and Cold that happen there, being incompatible with an *Animal* Life. But that which makes the Caſe much worſe than in any part of our *Globe*, upon this Suppoſition, is, that the Rays of the *Sun* wou'd be both direct, and there cou'd be no Rains nor Winds becauſe it is the cooling of the Air, that is the cauſe of both; which by no means cou'd happen in our Caſe, every ſucceeding Hour heating the Air to a greater Degree than the former. Add to all theſe, that our Seas even notwithſtanding our *Tides*, wou'd either be exhal'd, or turn'd into Deſarts of Salt, and ſo, not only our Fiſhes wou'd be deſtroy'd, but we cou'd have no freſh Waters, ſeeing we cou'd have no cool Air to ſend them down: If we had any *Plants* or *Vegetables*, they wou'd be but of one particular kind, *viz.* thoſe which require the greateſt Degrees of Heat, but it is demonſtrable we ſhou'd have Occaſion for none; for any Body who underſtands the *Animal Oeconomy*, will eaſily ſee that no *Animal*, ſuch as we have on our *Globe* now, cou'd bear ſuch an exceſſive and uninterrupted Degree of Heat. Upon all which Accounts it is very plain, that the preſent *Rotation* of the *Earth*, about her *Axe*, is one of the moſt ſignal Inſtances of Wiſdom and Contrivance, that can be imagin'd.

§ XXV. Next let us combine this *Diurnal Rotation* of the *Earth*, about its own *Axe*, with the *Annual Revolution* of the ſame about the *Sun*, and the *Paralleliſm* of the *Axe*, of the *Diurnal Rotation* with it ſelf: And from thence we ſhall have the beautiful Seaſons of the Year; Seed time, and Harveſt, Summer, and Winter; the comfortable Viciſſitudes of colder and warmer Periods, of Snow, and Rain, Winds and Calms, of ſhorter Days, and longer Nights, and again of longer Days, and ſhorter Nights, and of all thoſe delightful Changes, which are ſo Pleaſant, Comfortable, yea, and Neceſſary in our preſent Circumſtances. If the *Earth* had only turn'd about her own *Axe*, once in twenty four Hours, then all our *Viciſſitudes* wou'd have been of Days, and Nights; which by no means wou'd have been ſufficient for *Vegetation*. If the *Earth* had made a *Period*, about the *Sun*, once in the Year, without any *Rotation*, we ſhou'd have had but one long Day, and another equal Night; which as I have ſhewn, wou'd not have agreed, neither with Life, nor Vegetation. If both theſe had been united without the third of the *Paralleliſm* of the *Axe* of the *Diurnal Rotation* to it ſelf, we might have had Days and Nights, but our other Seaſons wou'd have been uncertain, and in ſome Places none at all; and ſo the Effect of the annual Revolution wou'd have been deſtroy'd in ſome Meaſure. But by this wiſe Conjunction of all theſe three Modifications, we enjoy our Seaſons, and the other conſequent Changes of the Year, which are of ſo great uſe to us; for had we enjoy'd a conſtant uniform Seaſon all the Year round, ſuppoſe of Summer Weather, then our Ground had been exhauſted, and worn out by conſtant bringing forth of *Vegetables*, and wou'd have run into Weeds, and thoſe other Plants that require the leaſt rich Soil, and moſt Heat only; ſo that in a few Years the *Earth* wou'd have been reduc'd into a *Wilderneſs* of needleſs Herbs; for toward the Production of the more uſeful Plants, there is requir'd (beſides a certain Degree of Heat and Moiſture,) a *Lixivial Nitrous* or *Urinous Salt*, which keeps the Mould looſe (for receiving the moiſt Air, and for the entry of that Heat and Moiſture.) For tho' *Salts* conſolidate Water, which conſiſts of ſolid porous Parts, whereby their Particles are ſtuck together, yet they keep the Parts of Mould or Sandy Clay (which has little or no Water) aſunder, and looſe, by the ſame very Reaſon, for their Particles not allowing them entry into themſelves, they get betwixt 'em, and firſt ſeparate their Union and then keep 'em from coming together; and perhaps both forward the Motion of the Liquors in the *Vegetable* Channels (which are certainly endow'd with ſome Degree of *Elaſticity*, and capable of being ſtimulated, as is evident in younger Twigs and Branches, as well as *Animal* ones) and endows the Juices with the Qualities the *Plant* requires. Now theſe are either quite exhauſted, or deſtroy'd, by conſtant Growth and *Vegetation*. We ſee the beſt Ground wears out in a few Years, and turns into wild uſeleſs Weeds; and all the Materials for enriching Ground, are gathered from Places, debarr'd from the Action of the *Sun*, and the Expences of *Vegetation*, but expos'd to the Air, and Weather, whereby they are impregnated with this *Nitrous* or other *Salts*: Such are old Turf, new Mould, the Dung, and Excrements of *Animals*, or thoſe things which abound with *Lixivial Salts*; ſuch are burnt Wood, burnt Turf, Stubble, and the like. Now all theſe, wou'd by a ſhort Time's uninterrupted *Vegetation* have been quite ſpent. Add to theſe, that in a perpetual *Summer*, there wou'd not fall ſufficient Quantities of Rain, to moiſten and ſoften the Mould, to that degree that it is neceſſary for conſtant *Vegetation*; for we find there is twice or thrice as much Rain falls in the *Winter* ſix Months, from *September* to *April*, than in the *Summer* ſix Months; and yet all this is but ſufficient for one ſix Months *Vegetation*. Moreover, even the *Animals* themſelves, cou'd not conveniently bear a perpetual *Summer*; for we find now, that the cold of the *Winter*, by ſtopping the Pores of the ſenſible Perſpiration, keeps the Warmth more within, whereby there is a greater Quantity of Spirits generated, the Blood is leſs rarify'd, the natural Functions are more ſtrong, and perform'd with more Vigour, the Digeſtion is better, the ſenſible Excretions more natural, and leſs violent, and the Crudities of the preceding *Summer* are ſettled and digeſted, I mean, in healthful and ſound *Animals* (for the Caſe is quite otherwiſe in *Valetudinary ones*, as of neceſſity it muſt be) and in a moderate and not over tedious *Winter*; whereas in *Summer* the Blood is more rarify'd, the Spirits more exhauſted, the *ſenſible Perſpirations* more violent, and leſs natural, the Digeſtion worſe, and all the Concoctions leſs thoroughly perform'd. So that it is evident we cou'd bear neither of theſe States perpetually, the Change of the *one* being abſolutely neceſſary to qualify the Errors and Extreams of the *other*. If we had a perpetual *Summer*, we ſhou'd be reduc'd to meer *Skeletons*; if a perpetual *Winter*, we ſhou'd turn Dull, unactive *Drones*. Now perhaps againſt all theſe it may be objected, that there are rational Creatures, who inhabit this *Globe* of ours, who are perpetually in both theſe Extreams, and yet are found to be not at all diſpos'd, as I pretend they wou'd be. To this I anſwer, that tho' as to the Preſence or Abſence of the *Sun*, they may be much the ſame as I ſuppoſe, yet, there are other concurring Circumſtances, which ariſe from the *Viciſſitudes* of the Seaſons in the other Parts of the *Globe*, which alters the Caſe quite; for there are conſtant Seaſons of Rain, in the more *Southern* Countries, which fall for ſome conſiderable time, that both hinders the perpetual *Vegetation*, ſoftens the Mould, and fattens it for the next Crop; there are Clouds of Snow, and Rain, impregnated with theſe *nitrous Salts*, which are driven (by the Force of the Winds) from colder into theſe hotter Countries; and there falling, do enrich the Ground. Beſides that, even the Clouds, rais'd from theſe hotter Countries themſelves, when diſtill'd into Rain, are ſufficient for this end; for as I have ſaid before, the Air every where is full of ſuch *Salts*, as is known by Experiment. Let any one conſult *Varenius*, and he will be ſatisfied that theſe Southern Countries have *Winters*, tho' not of Snow, yet what is abundantly ſufficient to ſtop the perpetual *Vegetation*, to moiſten, ſoften, and fatten the Mould, and to cool the Blood, and other Fluids of the *Animals*. Now the Principal thing that makes this *Poetical* ſtate of a Perpetual *Summer*, unfit for the preſent Conſtitution of the *Animals* and *Vegetables*, is, that in ſuch a ſtate (either ariſing from only a *Diurnal Rotation*, without an *Annual*, or an *Annual* without a *Diurnal*) there wou'd not be that variety of Rains, and cool Breezes, nor conſtant, and Trade-winds, nor overflowing Rivers, and ſuch like Circumſtances, which are the Effect of this Combining theſe two Motions together. I need not ſhew the Inconveniencies of a perpetual *Winter*, every Body is ſufficiently ſenſible, that upon ſuch a Suppoſition, we ſhou'd have neither *Vegetable* nor *Animal* in a very ſhort Time; eſpecially of any conſiderable uſe, or value, ſuch as require a *Summer's* Heat, for their Growth; and as for *Spring* and *Autumn*, they are not ſo much diſtinct Seaſons from the two former, as Gentle *Gradations* and eaſie Steps, whereby the one ſlides into the other, through the intermediate Degrees. From all which it is evident, how wiſely theſe three ſo different Modifications, have been link'd together, for the Benefit of the Inhabitants of this *Globe*; for by theſe, we have ſufficient Heat in *Summer*, to ripen he Fruits that are the product of every reſpective *Climate*; and we are furniſh'd with Reaſon, and made capable of Induſtry, to transfer the Products of one Country to another; we have Rain, and cooling Breezes in the *Winter*, of thoſe Countries, where Heat is not wanting, to cool, ſoften and enrich the Mould, and to ſtop conſtant *Vegetation*; and we have Froſt and Snow in others, where the Heat is not to ſpare, to lock up the Mould from being waſh'd away, and to keep in either the natural, or adventitious Heats, 'till the time that all Circumſtances concur, to have the product of the Ground brought to its *Vegetations.*

§ XXVI. Come we now to conſider the *Obliquity* of the Plane of the *Ecliptick* to that of the *Æquator*, or of the *Axe* of the *Diurnal Rotation*, to the Plane of the *Annual Orbit* of the *Earth*, which makes an *Angle* of 66½ Degrees. I have already ſhewn, that if the *Equator* and *Ecliptick* had coincided, it wou'd have rendred the *Annual Revolution* of the *Earth* quite uſeleſs; for if the *Earth* had mov'd about its own *Axe*, and this *Axe* had been at right *Angles* with the Plane of the *Ecliptick*, the ſame Appearances as to the *Viciſſitudes* of Day and Night, had happen'd, whether the *Earth* had mov'd round the *Sun*, or not; and the Alterations of Seaſons, and all the Conſequences thereon depending, had not been at all; and what a hinderance this wou'd have been to *Life* and *Vegetation*, I have already ſhewn. Beſides that in the *Torid Zone*, the Heat wou'd have been intolerable, and not to have been endured; and in the *frigid Zones*, the Cold wou'd have deſtroy'd both *Animals* and *Vegetables*; and even in the *Temperate Climates*; the one half of 'em wou'd have made but a very comfortleſs Habitation, for ſuch Creatures as we now are; ſo that but only the other half, wou'd have been any ways, a tolerable Seat for rational Creatures, and five Sixths at leaſt of the whole Globe, wou'd have been rendred uſeleſs. But *God* who is wiſer than Man, has contriv'd the Matter much better; for by this preſent *Obliquity* of the *Ecliptick* to the *Equator*, we reap one very conſiderable Advantage, which is taken notice of *by my very learn'd and ingenious Friend* Dr. *John Keill*, and that is, that we beyond the forty fifth Degree of *Latitude*, and who conſequently have the greateſt need of *Sun*'s Heat, have more of it, take the whole Year about, than if the *Sun* had mov'd continually in the *Equator*; and they that live in the *Torrid Zone*, and the adjacent Places, even to the *Latitude* of forty five Degrees, who are rather too much expoſed to the Heat of the *Sun*, than too little, have by theſe Means, leſs of his Heat, than they wou'd have had, had the *Earth* obſerv'd a right Poſition. To theſe add, that ſince this *Globe* of ours, has been deſign'd for a Habitation of rational and irrational Creatures, of various *Tempers*, *Conſtitutions*, and *Diſpoſitions*, and for *Vegetables* of different *Natures* and *Virtues*, requiring different Degrees of Heat, and Nouriſhment, to Ripen, and to bring 'em to Perfection, (to ſhew the *manifold* Wiſdom of the *Author* of *Nature* in the Variety of every thing.) And ſince we find the preſent Heat of the *Torrid Zones*, very well fitted for all the kinds of *Animals* and *Vegetables* that inhabit and grow there, the Cold of the *Frigid Zones*, very tolerable to the *Inhabitants* and *Productions* of theſe Places, and the *Temper* of the intermediate ones, ſuited to theirs; thoſe *Animals* that cannot tranſport themſelves, and the *Vegetables* that require a greater Degree of Heat, not having too much, and the like *Animals* and *Vegetables*, that can ſuffer Cold, not having too little Heat, and the rational Creatures being endow'd with Reaſon and Means, to tranſport themſelves where they live moſt at eaſe. And ſince it was impoſſible to have accommodated, all theſe ſo various and different *Animals* and *Vegetables* in a place of an equable and uniform, (or, in one, and the ſame) *Climate*, it's evident that the preſent Situation of the *Axe* of the *Earth*, to the Plane of the *Ecliptick*, is the beſt (of that infinite Variety poſſible) that cou'd be, for our preſent Circumſtances; for by any other very conſiderable *Alteration*, all or moſt of the mention'd Advantages would be loſt. For all which Reaſons we can never ſufficiently admire the *Wiſdom* of the *Author* of *Nature*, who has provided ſo liberally, and prudently for his Creatures.

§ XXVII. The ſame divine Wiſdom, is conſpicuous, in the Situation of the *Earth* in reſpect of the *Sun*; for had the Diſtance between the *Earth* and the *Sun*, been the ſame with the Diſtance between *Mercury* and the *Sun*, *i. e.* were we brought three times nearer the *Sun* than we are, or the *Sun* brought three times nearer us than he is, our Ground in Winter, wou'd have been hotter than red hot Iron, and what a Condition we ſhou'd have been in then, we may eaſily gueſs. On the other Hand, had the *Sun* been remov'd from us, or we from the *Sun*, to the Diſtance *Jupiter* or *Saturn* are remov'd, our hotteſt *Summers Day* had not afforded ſo much Heat, as thoſe that now live under the very *Polar Star* (if any ſuch there be) of our Globe, feel in the midſt of Winter. Are not we then very wiſely provided for, who are put in ſuch Mediocrity, ty, between theſe two extreme Diſtances; that neither our Heat nor Cold is ſo violent; but that we may either endure 'em, or with a little Induſtry fence our ſelves againſt their Injuries? Again, as to the *Figure* of our *Earth*, we are certain from its Shadow in the *Ecclipſes* of the *Moon*, and a great many other experimental Obſervations that it is *Spherical*, *Spheroidical*, or *Orbicular*: Bating the inequalities the Mountains make, and this Figure is a wiſe and beneficial Contrivance, not only as it is the moſt Capacious, and renders all the parts of its Surface equidiſtant from its Center of Magnitude, and alſo from its Center of Gravity pretty nearly, whereby the equability of its *Rotation* about its *Axe*, and of its *Circumvolution* in its *Orbit* is preſerv'd, and all the Motions on its Surface in all its Parts are rendered Uniform and Similar. But alſo, as the *Ingenious and Reverend* Mr. *Derham* has obſerved. 1. Becauſe this Figure is the fitteſt of any for a regular and gradual Reception and Surrendry of Light and Heat, both theſe being admitted, and given of, by more ſlow, creeping, and inſenſible Degrees than they cou'd be were the *Earth* of a Figure made of plain ſides or any other Figure whatſoever. 2. Becauſe this Figure is the fitteſt for a regular and equal Diſtribution of the Waters, which being a heavy Body, wou'd fall more unequally towards ſome one ſide or other, were the *Earth* of a Figure made up of equal or unequal Plains. 3. Becauſe this Figure is the moſt proper for an uniform and equal Diſtribution of the Winds and the other Motions of our *Atmoſphere*, for we find, that large *Mountains*, *Bays*, *Capes*, and *Headlands*, alter and diſturb in ſome meaſure the uniform Propagation of the Winds, even of the general and conſtant *Trade-winds*, and if the *Earth* were of a *Multiangular Figure*, the advantages ariſing from regular Winds and Fannings of the Air wou'd be diſturb'd and deſtroy'd to a much higher Degree. Now theſe are ſome few of the Advantages of an *Orbicular* Figure in general, but as to the prolate *Spheroidical* Figure in particular, tho' it be the neceſſary Reſult of the *Earth's Rotation* about his own *Axe*, and the Fluidity of its ſuperficial Parts, at the Commencement of this Rotation; yet it alſo is very convenient for us. By the *Earth's* Motions about its *Axe*, the Parts endeavour to recede from the ſame *Axe* as much as they poſſibly can, by a *centrifugal* Force, ariſing from the circular Motion; and therefore, if the Matter of any of the Heavenly Bodies, was Fluid, at the Commencement of this circular Motion, it wou'd neceſſarily have riſen from the *Poles*, and accumulated at the Equator, and ſo induced a *ſpheroidical* Figure on the *Planets* Body, generated by the *Circumvolution* of an Ellipſe about its leſſer *Diameter*. Now ſince it is evident to our ſight, aſſiſted with a good *Teleſcope*, particularly, in *Jupiter*, that the *Diameter* at the Equator is longer, than that at the *Poles*, and ſince Sir *Iſaac Newton* has demonſtrated that Earth is at leaſt ſeventeen Miles higher at the Equator than at the *Poles*, and ſince many repeated Experiments on the lengths of *Pendulums* in different Latitudes have confirm'd the ſame, its plain that at the Commencement of the diurnal Rotation, the Surface of the *Planets* has been covered with a Fluid; which gives an Account why at every forty or fifty Fathoms, below the Surface of our Earth, we never miſs of Water. It is likewiſe evident from this Figure of the Body of the *Planets*, that the Surface of the *temperate Climates* is larger than it wou'd have been, had the *Globe* of our Earth, or of the *Planets*, been either *ſpherical* or *oblongly ſpheroidical*; ſo that the Advantage of this Figure is very conſiderable, the Surfaces of the *Polar Regions*, which by reaſon of the oblique Incidence of the Rays of the *Sun* upon them, are colder, and leſs convenient for the Habitation of *Animals*, and the Production of the nobler Sort of *Vegetables* are hereby conſiderably leſſened, and the Surfaces or Space about the *temperate Zones*, which are moſt comfortable and uſeful, are thereby conſiderably enlarged. The ſame Figure obtains not only in the *Earth*, and the reſt of the *Planets*, and their *Satellits* but likewiſe in the *Sun*, and univerſally in every fluid Body revolving about an *Axe*.

§ XXVIII. Having ſhewn ſome of the Advantages ariſing from the ſeveral Motions of the *Earth*, and the Combination of theſe, which are common to the other *Planets*, I come now briefly to conſider, thoſe that poſſibly may be more particularly belonging to our *Globe*, and are not the immediate Conſequence of its Motions; and the firſt in order is our *Atmoſphere*, of ſuch Neceſſity toward the ſubſiſtence of *Animals*, and the growth of *Vegetables*, that neither cou'd ſubſiſt any conſiderable time without it. This *Atmoſphere* is a thin *elaſtick* Fluid, intermixt with Particles of different Natures, ſurrounding our *Globe* to the heighth, of about forty or forty five Miles. The Nature and Properties of this Fluid, I have in ſome meaſure ſhewn already. But ſome of its uſes I ſhall now point out, and firſt as to *Vegetation*, Dr. *Grew* and *Malpighi* have ſhewn that it is a principal concurrent therein, and by Experiments on Seeds ſown in Earth and put in an exhauſted *Receiver*,

ceiver, it has been proved that no *Vegetation* can ſucceed without it, what makes it ſo neceſſary ſeems to be becauſe it being more eaſily rarified, and heated by the *Action* of the *Sun*, than other more compact, heavy, and leſs *ſpringy* Fluids, is fitter to promote the Aſcent of Juices in the ſlender Channels of *Vegetables*, and there being no Fluid without a conſiderable Portion thereof, lodged up and down among its Parts, the firſt impulſe of the Juices upwards, does thence ariſe. As alſo becauſe of its active, ſpringy and ſubtile Nature, it rarifies, actuates and refines the more ſizy *Vegetable* Juices to promote their Circulation and performs Functions, on them *Analogous* to that it does on the animal Fluids. Next as to *Animals* it is well known, that they cou'd live but a few Minutes without this *elaſtick* Fluid, and probably that which ſo ſuddenly kills thunder-ſtruck *Animals*, is the quick and violent Rarefaction of the Air about them; for the *Lungs* of all ſuch upon opening, are found quite deſtitute of Air, and the ſides of their *Veſicles* quite clapp'd together. It's certain, that the Blood is ſent from the right Ventricle of the Heart to the *Lungs*, and if the Veſicles thereof be not diſtended or blown up, by the Air, the *Circulation* muſt ſtop there, and the *Animal* periſh; and both for the Comminution of the Particles of the Blood, that they may more eaſily paſs through the *Capillary* and terminating Veſſels, and for the Propagation thereof in the wider ones, there is neceſſarily requir'd a Fluid of a determinate Gravity, and *Elaſticity*. We have as great Difficulty of Breathing, in a thin (as is evident from the difficulty of Breathing on the tops of high Mountains, and from Experiments on Animals in nearly *exhauſted Receivers*) as in a thick Air; and ev'n in *Fiſhes*, where the Water in ſome meaſure ſupplies the want of Air, yet if you draw out all the Bubbles of Air, which are always found in Water, they will languiſh and die; and in great Froſts, if the Ice be not broken to admit freſh Air, the *Fiſh* in *Lochs* and *Ponds* will languiſh and die, not to mention here their *Swimming-bladders*, which are ſo neceſſary to them, and communicates with the Air in their *Gills*. So that even to them, a certain Portion of this *elaſtick* Fluid, is neceſſary. Now how well is this Fluid fitted for the generality of the Inhabitants of this *Globe*? It being neither too heavy, nor too light, neither too much, nor too little *Elaſtick*, for the uſes of Reſpiration. Another Advantage we reap by our *Atmoſphere*, is, that by it our *Clouds* and *Vapours* are ſupported, without which we ſhou'd neither have freſh Water, nor Snow, nor Rain, nor any of thoſe things, which moiſten and enrich our Soil, and make it fit for *Vegetation*. For tho' it be the *Sun* that rarifies the Water, and makes it take its firſt flight in *Vapours*, and *Steams*; yet its by the *Atmoſphere*, its Progreſs is continued to the upper Regions, and ſupported when it is there, to be afterwards form'd into Snow, or Hail, or Rain, or carried into other Regions, whoſe Soil does want it more. Every Body knows, that if there were no *Atmoſphere*, but a perfect *Void*, around the *Earth*, the Action of the *Sun*, wou'd not be able to raiſe the *Vapours* above a few feet, from its Surface; and that it's only the *Atmoſphere*'s being *ſpecifically* heavier, than theſe *Vapours*, that buoys 'em up in the Air, by its greater Tendency toward the Center. Now then, if there were no *Atmoſphere*, the *Vapours* cou'd riſe to no ſufficient heighth, and ſo cou'd never be cool'd ſufficiently, ſo as to be form'd into Snow, or Rain; for at a ſmall diſtance from the *Earth*'s Surface, the reflected Rays of the *Sun*, make the Places ſo warm, that no *Vapour* cou'd be turn'd into Snow, or Rain, there; for it's the coldneſs of the upper Regions, (being deſtitute of theſe reflected Rays) and the length of their Deſcent, that forms theſe *Clouds* and *Vapours* into Snow, and Rain, whenever the ſupporting *Atmoſphere* becomes lighter, than theſe accumulated *Vapours*, they fall down with the Temper of Heat or Cold, they had in the *upper Regions*, and ſo became Snow, or Rain accordingly. So that it's plain, it's our *Atmoſphere* that is one of the principal Means of our Dews, and Rains, and all the Bleſſings, that follow upon theſe. A third Advantage of our *Atmoſphere* is, our *Breezes* and our *Winds*, which carry our Ships upon the *Sea*, and purify our Air, from noxious Steams, which (with the Concurrence of the *Sun*) melt our Snows, and dry our Ground when over-moiſtned; and ſerve for ſo many other Purpoſes, for the Accommodation of Humane Life. *Wind* is nothing but a violent Motion of the Air, produc'd principally by its Rarefaction, more in one Place than another, by the *Sun*'s Beams, the *Attractions* of the *Moon*, and the Combinations of the *Earth*'s Motions. Without our *Atmoſphere*, we ſhou'd have no more *Wind* above, than under Ground, and ſo be depriv'd of all the Benefits ariſing thence. Laſtly, Our *Atmoſphere* is the Vehicle and *Medium* of Sound, that Senſe which moſtly diſtinguiſhes us from *Fiſhes*, and the inferior ſort of *Inſects*. *Sound* is nothing but a *Modulation* or *Percuſſion* of the Air, communicated by an impulſe, from the vibrating ſonorous Body, and propagated in *Undulations*,

dulations, through the Fluid of the *Atmoſphere*, ev'ry way round. Without our Air we ſhou'd not be able to hear the Report of a thouſand Pieces or Ordinance diſcharg'd at the ſmalleſt diſtance, as is evident from the Experiments on Sounds in exhauſted *Receivers*. We ſhou'd have no ſuch thing as Languages or *Muſick*, and what a comfortleſs ſtate this wou'd be, I leave the Reader to judge. Add to all theſe, that it is to our *Atmoſphere* the Beauty, variety of Colours, and Figures, which are painted on the Skies, the Lightſomneſs of our Air, and the *Twilight* are owing. By it the day is protracted, and the night ſhortened, and in theſe places moſt, which want thoſe moſt. By the *Refractions* of our *Atmoſphere*, the *Sun* riſes ſooner, and ſets later in Appearance, and with its beneficial Conſequences, even a Month ſooner in ſome places than it would otherwiſe. And the Land and Mountains, appear ſooner to the weary wandring Sailor. Theſe are great and noble Advantages to the Inhabitants of this Globe, as they beſt can tell, who by Accidents are ſometimes deprived of them. From all which it's very plain that there was *Counſel* and *Deſign* in the Contrivance and Production of our *Atmoſphere*.

§ XXIX. The next thing in Order to be conſidered is, our *Mountains*, without which it were almoſt impoſſible for *Animals* to ſubſiſt, or *Vegetables* to grow, they being one of the principal concurrent Cauſes toward the Production of our freſh-water Rivers. It has been ſhewn from Calculation, by ſeveral Perſons, and particularly the ingenious and learned Profeſſor of Geometry at *Oxford*, Dr. *Ed. Halley*, that the *Sun* raiſes Vapours from the Surface of the Sea, in a Year, ſufficient to ſupply all the Rivers with freſh Water for that time. Now theſe Vapours being rais'd (the *Sun* acting upon the Surface of the Sea, as a Fire under an *Alembick*, by rarifying the ſame, it makes the lighteſt, *i. e.* the freſheſt Portions thereof, to riſe with it firſt; and it rarifies the Water by the Inſinuation of its active Particles among the porous Parts thereof, whereby they are put in a violent Motion innumerable different ways, and ſo are expanded by the compound Fluid of Heat and Air, or hot Air, which carries up with its every little *Volum*, a *Cover* of the more glutinous Fluid of Water which becomes a little *Bubble* of hot Air incloſed within a ſhell of Water, whereof a great number conſtitutes a Vapour, which being thus form'd into little *Bubbles* of larger Dimenſions than they formerly had, by the inteſtine Motion raiſed by the Heat on the Air and Water, which makes their parts turn round their

Centers of Gravity, and ſo to poſſeſs more Space, and likewiſe to fly from one another, and by theſe means being become *ſpecifically* lighter, they are buoy'd up by the weightier *Atmoſphere*) and that this is pretty nearly the Fact, in the production of *Vapours*, may be evident to any one who will view theſe Vapours raiſed from common water, by a culinary Fire with a *Microſcope*, through a Beam of the *Sun*, which will preſently be ſeen to be innumerable little Bubbles of Water, of different Magnitudes according to the different Force of the Heat in blowing them up. A ſmall Heat throws off but few Vapours, and ſmall Bubbles, a greater Heat, groſſer, larger, and more numerous *Globules*. And a very great Heat, ſo weighty, large, and many *Veſicles*, that the Air is not able to receive and buoy them up, and ſo produces a boyling in the Water. And every one knows that cold ſolid Bodies, intercepting Vapours, will condenſe them into Moiſture, watery Drops, and Water. From all which it is evident that *Vapours* may be raiſed by the *Sun* in ſuch Quantities, as is ſufficient to make Clouds, which reſting in thoſe Places, where the Air is of equal Gravity with them, are carried up and down the *Atmoſphere*, by the Courſe of that Air, 'till they at laſt hit againſt the ſides of the more eminent and *Moun-*

Mountanous Places, of the *Globe*, and by this Concuſſion are condenſed, and thus become heavier than the Air they ſwom in, and ſo gleet down the rocky Caverns of theſe *Mountains*, whoſe inner Parts being hollow, and ſtony, afford them a *Baſon*, 'till they are accumulated in ſufficient Quantities to break out at the firſt *Crany*; whence they deſcend into the Plains, and ſeveral of them uniting, form Rivulets, and many of theſe Rivers; ſo that it is evident the great Benefit of theſe Eminences is not, that by the Shock theſe Vapours get in their Courſe from them, they are condens'd, ſo as to be precipitated thereby through the Chinks of the Rocks, but that afterwards in their Bowels they are preſerv'd, 'till they be of ſufficient quantity to form Rivulets, and then Rivers; for doubtleſs our Vapours wou'd fall in Rain, and Dew, tho' there were no *Mountains*, but then they wou'd fall equally, over conſiderable Places of the *Globe* at once, and ſo wou'd be ſuck'd up in the Ground, or make an *univerſal Puddle*; whereas by theſe *Mountains*, they are perpetually almoſt, (at leaſt a Nights) pouring down in ſome particular Places, and there treaſuring up, for a conſtant Supply to the Rivers. Not that other Cauſes may not concur toward the Production of Fountains, Rivers, and freſh Water, beſides the raiſing of Vapours by the Heat of the *Sun*, to deſcend in *Rains*, *Miſts*, and *Dews*. They might be raiſed from the *Sea* by *Subterraneous* Heats, and percolated from their Saltneſs, by being ſtrain'd through Earths and Layers of Minerals of different Natures; but it is not eaſy to conceive, how any ſtraining can bring ſalt Water to that degree of freſhneſs, our Rain, and Snow Water is brought. All the artificial ſtrainings, tho' never ſo often repeated, and through whatſoever kind of Sands or Earths, hitherto diſcovered and made uſe of, ſtill leave a *Brakiſhneſs* in ſalt Water, that makes it unfit for *Animal* uſes; neither does there appear any kind of natural Operation, ſufficient for this purpoſe, but this natural *Sublimation* and *Diſtillation* of Vapours into *Dews*, *Miſts*, and *Rains*, which makes it very probable that this is the principal efficient in the Production of Rivers and Fountains. As to the *perpetuity*, and *equability* of ſome Fountains, where there are no conſiderable Mountains over and above what is to be expected from the uncertain and unequal falling of *Rains*, *Miſts*, or *Dews*, nothing can be concluded from thence, unleſs the Extent and Capacity of the *Reſervoirs* of falling Rains in the Bowels of the Earth were certainly known. For the freſh Water may be convey'd to ſo great a diſtance, and in ſuch a quantity, and to ſo great a depth, by the ſituation of the internal Channels, as may be ſufficient to raiſe it in larger Streams, than any Fountain Head as yet known can ſend out, and the depth and diſtance of the Baſon may hinder it from ſending out *Senſibly*, more Water at one time than another. Tho' if the Quantity were preciſely the ſame at all times, in theſe *perennial* Fountains, the difficulty wou'd be greater. However, whatſoever the Origin of Fountains may be, ſtill Hills are the *Reſervoirs* in this great Work. Another very conſiderable uſe of theſe *Hills*, and *Eminences*, is the Determination of theſe Rivers; for tho' there had been Rivers without Mountains, (which is hardly poſſible) yet in that caſe the Rivers cou'd only have run in a ſtraight Line, if they had run at all; whereas, by theſe *Eminences*, plac'd up and down the *Globe*, the Rivers make innumerable beautifying turnings and windings, whereby they enrich, fatten, and water the Soil of ſeveral different Countries in one Courſe, make the Tranſportations and Carriage over Lands more eaſy and manageable, and at laſt diſembogue in ſeveral Mouths into the *Sea*; where, by the aſſiſtance of the *Tides*, they form Harbours and Ports, for the convenience of *Shipping* and *Navigation*. All theſe Advantages we have by our *Mountains*; for tho' from other Cauſes, we might poſſibly be ſupply'd with freſh Water *Springs*, (tho' Nature ſeldom is *Luxuriant* in diverſity of Cauſes) yet without our *Mountains* we cou'd never have Rivers, nor cou'd theſe Rivers have ſuch delightfull turnings, nor thoſe uſeful falls, which gives them an impetuoſity that may be improv'd to ſo many delightful as well as profitable Uſes. Laſtly, If we conſider what theſe Hills in their own Nature and Cauſe are, we ſhall plainly perceive their Neceſſity and Uſe: A Hill, is nothing but the *Neſt* of ſome *Mettle* or *Mineral*, either of *Stone*, *Iron*, *Tin*, *Copper*, or ſuch like lower *Vegetables*: Theſe *Mettals* and *Minerals*, by a *plaſtick* Virtue proper to themſelves, and the efficacy of *ſubterranean* Heat and Fires, converting the adjacent Earths into their Subſtance, do encreaſe and grow as truly as *Animals* or *Vegetables*, and requiring free Paſſage both for Air and Water to aſſiſt in their formation: By their Growth, and the Heat of the ſubterranean Fires, raiſe and puſh upward the Surface of the Earth according to the neceſſity of their Nature, and the quantity of the *Metallick* or *Mineral* Bed. I do not ſay that all Mountains owe their *Origin* to ſuch Cauſes, *ſubterraneous* Fires have thrown up Mountains of *Mineral* and *Metallick* Beds, already form'd, the *Sea* and *Tides* have thrown up Banks and Bays of Stone and Sand, Currents and Streams in proper Situations, meeting and juſtling have form'd Eminences of different Sizes and Matter: And Art and humane Induſtry has raiſed ſome. But generally and for the moſt part, all the eminent Mountains are found to be Neſts, and Beds of *Minerals* and *Mettals*, which have large hollow Cavities, for Water and Air, and whenever they have been digg'd into, theſe have been found in them, with all the appearances of ſome parts of them a forming and growing in a manner proper to them, and *analogous* to the Vegetation of Plants. The manner how they are produced is not here neceſſary to be enquired into, but that *Mettals* and *Minerals* are encreaſed and do grow is paſt all doubt, and is confirm'd by all Miner's and Diggers: And that there may be *ſubterraneous* Heats ſufficient to raiſe them into *Hills* and *Mountains*, is evident from ſome, ſo formed near *Vulcano*'s and burning Mountains: And the Force and Violence with which theſe Burn and throw out ſuch Maſſes of *ſtony*, *ſulphurous*, and *earthy* Matter. From all which it is evident our Mountains are as neceſſary as our *Mettals* and *Minerals* are. I do not mention here their uſe and advantage for the production, ſhelter, and nouriſhment of ſome ſorts of Vegetables and Animals which cou'd not grow or live ſo well any where elſe. But from the whole we may ſee of what Advantage theſe unſightly Mole's (as ſome thought them) are to the Accommodations and even Neceſſities of living.

§ XXX. Next come our Fluids to be conſidered, without which we cou'd never have been, ſeeing they are a very *eſſential* part of us; that which I ſhall principally take notice of, is, 1. The fewneſs of the *original* and *primary* Fluids, in reſpect of that vaſt Number of compounded ones, which are indeed numberleſs. The *primary* ones hitherto certainly known, are only four, *viz.* *Air*, *Water*, M*ercury* and *Light*; three of which are but ſeldom much compounded with others, ſo that it is Water alone, or *Lymph*, that is the *Baſis* of all our Mixtures, and it is the parts of ſolid Bodies floating in this Fluid, that produces all our delightful and uſeful varieties of Liquors; ſo frugal is Nature in *Principles*, and ſo fruitful and various in Effect and Compoſitions. 2. The great difference between the *ſpecifick* Gravities of our Fluids, M*ercury* being about 8000 times heavier than *Air*. Now not to mention the many uſes of this laſt Fluid in Artificers Works, had *Air* been as heavy as M*ercury*, it had been altogether uſeleſs in Reſpiration; on the contrary, it had choaked us immediately; and had there not been a Fluid of the ſame weight with M*ercury*, *i. e.* a collection of exceeding ſmall, vaſtly heavy *Spherules*, in the preſent Circumſtances of Mankind, I do not know what a great part of the World would have done. For the Lewdneſs and Debauchery of Mankind, has brought a great many Diſeaſes to that degree of Malignity, that I ſcarce ſee how a thorough Cure cou'd be made of 'em, without this Fluid; for it's certain whenever any Diſtemper ariſes from an obſtruction of the Blood Veſſels, wherein the Blood and its Veſſels, are chiefly concerned (for in *Nervous* Caſes I am ſatisfied it is pernicious, in great Quantities eſpecially) that this Fluid, if not abſolutely neceſſary, is extremely beneficial; for nothing has ſufficient force to take away this obſtruction, and to ſeparate the *Globules* from one another, in the extreme *capillary* Veſſels, but a little weighty *Sphere*, ſuch as the Particles of *Mercury* certainly are. Now by this difference of the *Specifick* Gravity of the Fluids, a Remedy is provided for all theſe Maladies, which I am ſatisfied are more than two or three. But that which is moſt wonderful in theſe Fluids, is, 3. The univerſal condition of the direction of their *Preſſure* upon the ſides of the containing Veſſel; for in all Fluids of whatſoever kind or nature, this *Preſſure* is communicated in Lines *perpendicular* to the ſides of the containing Veſſel,

ſel. Now this property of Fluids, which is ſo beautiful and uniform, is the neceſſary Conſequence of the *Sphericity* of their conſtituent Particles; for ſince by the third Law of Nature, *Reaction* or *Repulſe* is always equal and contrary to Impulſe or Action, in the ſame Direction, conſequently the ſides of the containing Veſſel preſſes the contain'd Fluid, as much as the contain'd Fluid preſſes the ſides of the containing Veſſel; and this *preſſure* of the ſides of the containing Veſſel, is directed in the ſame right Line with that of the contain'd Fluid, but is contrary to it. Now ſeeing a *right Plane*, can only touch a *Sphere*, in a point, and can preſs it in a direction through that point of Contact; if this Direction through the point of *Contact*, do not likewiſe paſs through the Center of the *Sphere*, the *Sphere* will neceſſarily revolve upon *Plane* till the Direction of its *preſſure*, from the point of *Contact* paſs through the Center of the *Sphere*; juſt ſo likewiſe, if a *Plane* preſs two *Spheres*, in the ſame Direction, the Line of this Direction will neceſſarily paſs through both their Centers. And ſo if there be any number of *Spheres* whatever, preſs'd by a *Plane* in the ſame Direction, the Line of this Direction will neceſſarily paſs through all their Centers. But a Line through the Center of a Sphere from the point of Contact, is *perpen-*

perpendicular to the *Tangent Plane*; and ſince this is the Direction of the *preſſure* of the *Plane* upon the *Spheres*, it is alſo the Direction of the *preſſure* of the *Spheres* upon the *Plane*. Since alſo the Particles of Fluids, are *Spherical*, or nearly approaching thereto, and ſince they are ſuppos'd exceeding ſmall, as alſo ſince *curve* ſurfaces are compounded of an infinite Number of little plain ſurfaces, it is univerſally true, that all Fluids of what nature ſoever, preſs the ſides of the containing Veſſels in a Direction *perpendicular* thereto. And on the other hand, ſince by *experience*, it is found true, that Fluids do preſs the ſides of the containing Veſſels, in a Direction *perpendicular* thereto, it's certain that the Particles of all Fluids are *Spherical*, or nearly approaching thereto; ſo that this is now no more *Hypotheſis* but *Demonſtration*. Now cou'd any thing but the Fingers, and *Almighty Power* of God, have rounded thoſe infinite numbers of ſmall Particles, whereof Fluids conſiſt? Or cou'd any thing but his *Wiſdom*, have aſſign'd them their true dimenſions, their exact Weights and requir'd Solidities? We ſhall allow him to continue in his infidelity who can demonſtrate by what Laws of *Mechaniſm*, all the Particles of Water were turn'd of the ſame *Diameter*, Solidity and Weight, and thoſe of Air, *Mercury* and *Light*, turn'd all of different *Diameters*, Solidities and Weights from one another; but all of the ſame *Diameters*, Solidities and Weights among themſelves.

§ XXXI. What a noble repreſentation of the Divine Wiſdom does our Fluid of *Light* afford us! how wonderfully are its parts fram'd! and with what a prodigious *velocity* are they ſent from the Body of the Sun! its Subtility is almoſt beyond imagination, no Pore ſo ſmall as to exclude it; no Stream of it ſo great, but may be congregated almoſt into a ſingle Point; no Surface ſo finely poliſhed, as not to ſcatter almoſt one half of it; its Rays traverſe through one another, millions of different ways, without interfering ev'n in the ſtraiteſt Paſſages; in one Word, we are not able to comprehend nor imagine a Number ſufficiently ſmall, to expreſs its ſubtility; in every pulſe of an *Artery*, it runs ſome *hundred and thirty thouſand Miles*; what an amazing, and unconceivable *velocity*, muſt this be! nothing but the action of the Mind, can any ways repreſent it: And then what a beautiful *Idea* of this Fluid, do Sir *Iſaac Newton*'s *later Diſcoveries* preſent us with, ev'ry Ray is endow'd with its own *Colour*, and its different degree of *Refrangibility and Reflexibility*. One Ray is *Violet*, another *Indigo*, a third *Blew*, a fourth *Green*, a fifth *Yellow*, a ſixth *Orange*, and the laſt R*ed*. And theſe are the *primary* and *original Colours*, and from the mixture of theſe, all the intermediate ones proceed, and *White* from an equable mixture of the whole; *Black* on the contrary, from the ſmall quantity of any of them being reflected; or, all of them in a great meaſure being ſuffocated. So that now it is not Bodies that are coloured, but the *Light* that falls upon them, and their Colours ariſe from their *Aptitude*, to reflect Rays of one Colour, and tranſmit all thoſe of another. Their prominent little parts, upon their Surfaces, according to their different Degrees of *denſity* and *thinneſs*, are apt to reflect back upon our *Organs*, Rays of one Colour, and of one degree of *Refrangibility* and *Reflexibility*, and to let others paſs through their Pores; and this one Colour too, is leſs or more intenſe, according as their prominent parts are of different *denſities*, or are thicker or thinner. For the firſt degrees of *Intenſeneſs*, in all the *primary* Colours, ſeem to ariſe from ſome determin'd degrees of *denſity* and *thinneſs*; and the ſubſequent degrees from the other different degrees of denſity or thickneſs or thinneſs, of the prominent little parts, of the Surfaces of Bodies. *Light* acts upon Bodies by heating, diſſolving, and putting their parts in a *vibrating* Motion; as alſo Bodies act upon *Light*, in drawing its parts to them, and that in Lines *perpendicular* to their Surfaces: All the differently *reflexible Light*, obſerves this one Law, that all the different *Angles* of *Incidences* are reſpectively equal to the *Angles* of *Reflexion*; and all the differently *Refrangible* Rays of *Light*, obſerve one Law likewiſe, *viz.* that in all the *obliquities* of the ſame Ray, to the Plane of *Incidence*, the *Sines* of the *Angles* of *Incidence*, are to the *Sines* of the *Angles* of *Refraction* in a conſtant *ratio*; and both theſe Properties proceed from one, and the ſame Principle, acting in different Circumſtances, *viz.* that Bodies attract *Light* in *Lines perpendicular* to their Surfaces, and that this attraction is equal in all the *Incidences*, and *Refractions* at eqnal Diſtances from the ſame *Plane*, and the *reflected* Rays are turn'd back before they arrive at the *reflecting* Plane: For if the *reflecting* Plane, have ſuch a force of *attraction*, that before the Ray arrives at it, it has already made the *Sine* of the *Angle* of *Incidence*, equal to the *Radius*, the Ray muſt reflect, and not enter into the reflecting Plane at all; if a leſſer degree of *attraction*, then muſt it enter the Body of the Plane, and proceed in the Line, that its direct *impulſe*, together with the degree of *attraction* in the *refracting* Body, neceſſarily generates. And as there may be different degrees of *Attraction* in Bodies, which produce their different degrees of *Elaſticity* and *Coheſion*, ſo there muſt be different degrees of *attraction* in *Mediums*, ſuppos'd, to account for their different *Powers*, in bringing the *refracted* Rays nearer to or farther from, the *perpendicular*; for it's well known, all *Mediums* have not the ſame *refractive* Virtue. Now what a beautiful, uniform, and ſimple *Theory* of *Light*, is here? this is ſo very like the *frugal ſimplicity*, and yet the *manifold variety* of Nature, that one would be almoſt tempted to believe it true, were there no *Demonſtration* and Experiment to confirm the truth of it. I might likewiſe ſhew here the Art and Contrivance of Nature, in the production of the *Coheſion* of Bodies. But having been pretty copious on this Subject already, I ſhall only ſuggeſt one very remarkable Inſtance of the wonderful Contrivance and Wiſdom of Nature, in the *propagation* of *Light*, *viz.* that a Ray of *Light*, in paſſing from a luminous Point, through two differently *refracting Mediums*, to illuminate a given Point; ſpends the leaſt time (the refracting Powers of the ſeveral *Mediums* conſidered) poſſible, and conſequently when the Rays paſſes, but through one and the ſame *Medium*, *i. e.* when a Ray paſſes from a luminous point, to reflect upon a given point, it takes the ſhorteſt way poſſible. This the *Geometers* have demonſtrated, and particularly, Mr. *Hugens* in his Treatiſe of *Light*, very elegantly *page* 40 *and* 41. Now I appeal to the Reader, how *incredulous* ſoever, if this be not an Inſtance of *Counſel* and *Deſign*, is not this like the Methods of *Prudence* and *Wiſdom*, which will not ſpend more time on a thing, than juſt what is neceſſary to do the Buſineſs; which will not go about, but take the ſhorteſt Courſe poſſible, that will bring it to the place deſign'd? He that can reſiſt ſuch pregnant and powerful Inſtances of Divine Wiſdom, will never be convinc'd.

§ XXXII. I ſhould next proceed, to ſhew the wonders in the *Bowels* of our *Earth*, but there our Diſcoveries are ſo few and our accounts of this matter, ſo lame, that little to be reckon'd certain, can be determin'd about theſe *Inner Regions*. Some have concluded that there muſt of Neceſſity be a Central heat, becauſe they ſaw that Springs run faſter in Froſt and Snow, than in hot Weather, but that might proceed from ſome of the other more narrow *outlets* of this *Baſon*'s being ſtopt, by the Froſt; and the *Vapours* that the Sun raiſes thence, being kept in. Others have thought that within this outer Cruſt of *Earth*, there muſt be a *Diſcontinuity*, for ſome conſiderable diſtance,

ſtance, quite round, and that there was ſucceeding this, a large *Sphere*, moving after a certain manner, to account for the *variation* of the *Magnet*; what Truth may be in that we muſt leave to Time and future Obſervations to determine. But the *Magnet* in it ſelf is a beautiful Inſtance of the Power and Contrivance of the *Author* of Nature, of the reality of *Attraction* in general in Bodies, and that different from their Gravities; and of their imperceptible Influences upon one another. For this wonderful *Foſſil* not only attracts and repells *Iron*, and all *Chalybeat* Compounds, and all other *Minerals* of the ſame Nature with it ſelf, according to their different Situations in reſpect of its *Poles*. But when *Iron* is duly impregnated with the Virtues it communicates, and properly managed, its Extremities at ſometimes points directly *North* and *South*, and thence varies both in the ſame and in different places of the *Globe*, in regular and uniform Figures, towards *Eaſt* and *Weſt*, according to the *Syſtem* of theſe Variations diſcovered by the *Learned and Ingenious* Dr. *Halley*. And very probably, as the common *Horizontal* Needle, is continually varying towards *Eaſt* and *Weſt*, ſo the dipping or inclining Needle is varying up and down, towards or fromwards the *Zenith*, according to the Suſpicions of the *Lear-*

ned and *Reverend* Mr. *Derham*, and poſſibly in a regular and uniform *Syſtem*, and there may be other beautiful and regular Qualities not yet diſcovered, in it all theſe mentioned being found out within leſs than 500 Years. There is a Ring about *Saturn* which moves differently from his Body that ſomewhat favours this Suppoſition of *Interior Orbs*, but I cannot come into the Opinion that this *Annulus* may be ſome remains of the Ruins of a Cruſt, that is fall'n in upon the Body of the *Planet*, becauſe this *Ring* appears to be regular and uniform, of an equal breadth quite round, and at an equal diſtance from the Body of the *Planet*; beſides, it is ſcarcely probable that theſe *Planets*, which like ours, may be deſign'd for the Habitation of ſome ſort of *Animals*, ſhou'd be ſo ruinous as this Suppoſition wou'd make that *Planet* to be. If it be true that all the Bodies of the Univerſe *attract* one another, and if it be very probable from the Benefits of our *Moon* to the *Earth*, that ſuch like and *analogical* Advantages, of raiſing Tides in the Fluids, reflecting Light in the Night Seaſons, and emitting other Influences for Life and Vegetation, acrue to the *Planets* from their *Satellits* and other *Appendages*, then it's very plain that whenever a leſſer Body (however figur'd) attends the Motions of, and revolves with a greater, that that leſſer Body is deſign'd by its *attraction*, and Influences to produce ſome effect, that is the Conſequence of this *Attraction* and theſe Influences. Thus it's plain, our *Moon* was deſign'd to raiſe our *Tides*, and regular Winds, to enlighten our Nights and to diſturb the Motions of our *Earth*, for Purpoſes that poſſibly we may, or may never, come to diſcover; and ſo the *Satellits* of *Jupiter* and *Saturn*, were deſign'd to attract their Fluids, and to enlighten their Nights, or diſorder the Motions of their reſpective *Planets*; or to produce ſome effect conſequent upon Attraction, and I have ſuggeſted before, that the Multitude of the *Satellits* of theſe *Planets* may ſerve in their vaſt diſtance from the *Sun*, to hinder their Fluids (by frequent and various Diſturbances) from freezing; and to enlighten their long tedious Nights, and the greater number of the *Satellits* of *Saturn*, than *Jupiter*, ſeems to favour this Conjecture. Now this *Annulus* may poſſibly ſerve ſome ſuch purpoſe as this, ſince it moves differently from the Body it ſelf. But all theſe are but Conjectures; and as ſuch I leave 'em. It's probable that *Earthquakes*, and *Vulcano's*, proceed from ſome Motion and Mixture of different Particles within the Body of the *Earth*; for as to a *Central Globe* of Fire, it is not eaſily to be conceiv'd how it can ſubſiſt without Air or Fewel, or without conſuming the contiguous Parts of the *Globe*, and if it had either Air or Fewel, it muſt make a greater Havock, than any Hiſtory mentions. Beſides, that it cannot well conſiſt with theſe mention'd *interior Orbs*, without confounding their regular Motions: All the Appearances of Nature which ſeem to require it, may be more naturally ſolved by the *Fermentation* of different Steams and Vapours, within the Cavity of the *Earth*. Theſe *Vulcano's* and fiery Eruptions, never happen but where Sulphur and Iron are copiouſly found, which we are certain may produce Heat and Flames when duly mixt and fermented, any where: And it's obſervable that there are ſcarcely any Country much annoyed with Earthquakes that have not one of theſe *fiery Vents*; which ſhows that theſe *Vulcano's* are the neceſſary Conſequences, and the *Tunnels* of the fermenting Vapours, in the Bowels of the *Earth*, and not Chimneys to the Central Heat: And this by the way is a bountiful Contrivance in Nature, to leſſen and evaporate theſe tumultuos Steams, which otherwiſe might make much greater Havock than now they do. Earthquakes and *Vulcano's* in the Earth being the ſame that Thunder and Lightning are in the Air, and from the ſame Cauſes: It is likewiſe probable that its *Strata*, *ta*, are not of ſuch Gravities as a regular ſubſidence according to the Laws of Gravitation of Bodies, wou'd require; which ſhews it has not been compounded by theſe Laws. It's certain, that we have freſh Water at any conſiderable depth, in moſt Places diſtant from the *Sea*; which ſhows how uniformly and equally this ſo abſolutely neceſſary Fluid has been diſtributed for the Benefit of the Inhabitants of this Globe; we have from its *Bowels*, all thoſe *Metals* and *Minerals*, with all their varieties, which are of ſo much uſe, for the Accommodations of *Life*, and the ſubſervience of *Medicine*; from the depth of the *Sea*, and the *Bowels* of the *Earth*, we have all our natural *Salts*, which do us ſo great and manifold Services. If any one had but occaſion, to look over the variety, beautiful Figures, and Colours of *Shells*, *Petrifactions*, *Ores*, *Minerals*, and *Stones*, and other natural Curioſities, (of which the nobleſt, and largeſt Collection, poſſibly now extant, is to be ſeen, in the Poſſeſſion of the *Induſtrious and Learned* Dr. *Sloan*) he cou'd not but admire the *manifold Wiſdom* of the Author of Nature. This were a very large and copious Field, and wou'd afford very *demonſtrative* Inſtances of *Counſel* and *Contrivance*. But I have ſo many other things to ſuggeſt on the Head I am about, that I muſt content my ſelf with *Generals*.

Chap. VI.

The Proofs for the Being of a God, ariſing from the Contemplation of the Humane Structure.

§ XXXIII. Having dwelt ſo long upon the *inanimate* part of this *Syſtem* of things, I come now to conſider the *Animal* Kingdom; that *noble* and *manifeſt Repreſentation* of the *Power* and *Wiſdom* of the *Author* of *Nature*. One of *Democritus* or *Des Cartes*'s Diſciples, may perhaps undertake to give ſome faint and imperfect kind of Explication of the *Celeſtial* Appearances, from their *Principles*, tho' how wretched their accounts of this Matter are, we have in ſome meaſure already ſhewn. But when they come to a *Plant*, or *Animal*, they are perfectly at a loſs, they can produce nothing coherent, or of a piece; their *Schemes* then, are like the effects of the caſual *concourſe* of *Atoms*, an odd inconſiſtent Mixture of things, that has neither Form, nor Beauty. For ev'ry part of theſe, is ſo exactly adapted, to ſome wiſe *Deſign*, ev'ry thing is ſo fitted, to its own proper uſe; and theſe Uſes are ſo manifeſt and evident, that they clearly argue, an infinite *Wiſdom*, an exact and exquiſite Knowledge, in the Laws of a Divine *Geometry* and *Harmony* infinitely ſuperior to our low Figures and Numbers, that nothing is ſufficient for, but a *Being* abſolutely *perfect*. I ſhall here, as I did in the *Celeſtial Philoſophy*, give ſome general *Scheme*, of the *Animal Fabrick*, and *Oeconomy*; and ſhall confine my *Speculations*, to the *Humane Structure*, as being the moſt perfect, we are acquainted with, and which being fully underſtood, the reſt will eaſily follow. I ſhall begin with the proceſs of the *Aliment* and the *Circulation* of the Blood.

§ XXXIV. The Meat being groſly divided by the Teeth, and ſoftned by the *Saliva*, is through the *Gullet*, by the Conſtriction of its *Fibres*, thruſt into the *Stomach*; where being ſwell'd and farther ſoftned by the *Succus* of its *Glands*, and the Liquors taken in, by the perpetual Motion of the Coats of the *Stomach*, againſt one another, the *Muſcles* of the *Midriff* and *Abdomen* employed in reſpiration, and poſſibly from other Cauſes, never to be known, its parts are broken, and their intimate Coheſions diſſolv'd. And by this *preſſure* of the ſides of the *Stomach* upon the contain'd *Aliment*, it is thruſt into the *Inteſtins*; at its entry into which, it is irrigated with the *Bile* and *Sweetbread-juice*, the one to ſweeten, the other to dilute the *Chyle*, by the *vermicular* Motion of the *Inteſtins* (ariſing from the alternate Action of their *Spiral* and *Longitudinar Fibres*) the *preſſure* of the *Midriff* and the *Muſcles* of the lower Belly, the groſſer parts are deriv'd downward, to be thruſt out of the Body, while the finer, are ſqueez'd into the narrow *Orifices* of the *lacteal* Veſſels, which open into theſe *inteſtines*; whence in ſlender Channels they are carried into the *Glands* of the *Meſentery*, receiving firſt a fine thin *Lymph* from the *Lymphatick* Ducts which dilutes this *Chylous* fluid, and ſcours its containing Veſſels, which from the *Meſenterick Glands* unite in larger Channels, and paſs directly into the common *Receptacle* of the *Chyle*, which is a Baſon, form'd for it by the Union of theſe *Lacteal*, and *Lymphatick* Veſſels; from thence in one Duct, it aſcends into the *Thorax*, and about the Heart ſometimes dividing, it immediately unites again, and creeping along the *Gullet*, it paſſes on to the left *Subclavian* Vein, where in one or two Mouths, it opens into that Veſſel, and there mixes with the Blood, and *circulates* with it, which *Circulation* is thus perform'd. The Veins (in a continued Channel, as is reaſonably to be ſuppoſed, with the *Arteries*,) bring the Blood from the Extremities of the Body, and all uniting in two large Veſſels, whoſe ſides diverge, from the *Vena Cava*, *Aſcendens* and *Deſcendens*, which two likewiſe join at their entry into the right Ear of the Heart, which in its *Relaxation* or *Diaſtole*, receives the Blood from them, and in its Conſtriction or *Syſtole*, thruſts it into the right *Ventricle*, which is then in its ſtate of Remiſſion: Which when contracted, drives it through the *Arteria Pulmonalis*, into the *Lungs*; whence it is receiv'd, in an uninterrupted Channel, by the *Vena Pulmonalis*, and is carried into the left *Auricle* of the Heart, then open to receive it; by whoſe Conſtriction, it is diſcharged into the left *Ventricle* then likewiſe dilated, by whoſe contraction it is puſhed into the *Aorta*, which bending a little upwards, ſends forth the *Cervical* and *Axillary Arteries*, the reſt turning down again, forms the deſcending Trunk, and theſe dividing into innumerable leſſer Channels, carry the Blood to the ſeveral parts of the Body, where leaving ſome of it's Particles proper for their uſe; the reſt is ſent into the *Veins*, which are nothing but the returning *Arteries*; and thus the Blood is carried about in a perpetual *Circle*, from the *Arteries* into the *Veins*, and from theſe to thoſe; and in this *Circulation*, duly perform'd, Life and Health conſiſt.

§ XXXV. As it is plain from what has been ſaid, that it is only the Blood, that is immediately recruited by the *Chyle*, ſo is it likewiſe evident from thence, that it is only from the Blood, that all the Expences of living are furniſhed, and that all the *Secretions* of what kind ſoever are deriv'd. Now theſe *Secretions*, are made by the aſſiſtance of the *Glands*, and a *Gland*, is an *Organ* conſiſting of ſome one or more Turns, Folds, *Convolutions* and Contextures of Veſſels, in a proper *Membrane*, for the ſeparation of one Liquor from another. The moſt conſpicuous *Gland* of an Animal, is the *Syſtem* of the *Guts*, where the *Lacteals* are the *emiſſary Veſſels* or *ſeparatory Ducts*: The *Meſentery* is the Membrane that keeps them in their natural Situation, and the *Periſtaltick Motion*, the ſeveral *Convolutions*, with the *Valves* of theſe long hollow Channels, are the *Mechanical Apparatus*, whereby the Chyle is ſeparated from the Food, and carried into the common *Receptacle*. The *Teſticles* when unfolded, give us another plain Conception, of a *Gland*, where the *Artery*, after having ſent the greateſt part of the Blood, by many little opening Branches, into the neareſt Vein, is carried on in a *Cylindrical* Figure, through many

Foldings and Plies, conveying through its ſingle *Tube*, the proper Liquor into a common Baſon. There is, no doubt, as great a variety of Structures in the *Glands*, as the different Liquors to be ſeparated are, for ſince the *Arterial* Blood is the common Subject, the Diverſity of the ſeparated Liquors muſt depend on the different *Structures* of theſe *Strainers*. Some, no doubt, are very Simple, ſuch perhaps are the *Glands* of Perſpiration, where a little Tube, jetting out from the Extremity of an *Artery* where it degenerates into a Vein, may be ſufficient to carry off theſe Vapoury Steams, of the Blood; tho' even here, *Anatomiſts* have obſerved Art, Contrivance, and Complication. But the ſtill more complicated, ſeem to conſiſt of a *Membrane*, forming (by the contexture of *Blood*, *Veſſels* and *Nerves*) an oval or round Baſon, for receiving the ſeparated Liquor, and of two or more *Ducts*, for conveying in, and carrying out of this Cavity, the ſeparated Liquor. This Membrane, is as it were a Stay and Baſe, for the Blood Veſſels and Nerves, to keep them in their natural Situation; and to form the Cavity. Here, the Blood Veſſels are interwoven into different Figures, Situations, and Inoſculations, according to the Neceſſity of the ſeparated Liquor. There are other *Glands* again, yet ſtill more complicated, but they are commonly no other, than a Maſs of the former, contain'd under one common involving *Membrane*, and having all their *emiſſary Ducts*, united in one large common Veſſel, which may enter into another *Gland*, as an *Artery*; and ſo a new Separation may be made, from the former ſeparated Liquor. I will not aſſert any thing poſitive about the *Mechanical* Explication of the ſeparation of one Liquor from another in an Animal Body. All I have hitherto ſeen on the Head, being either too general or too precarious: But ſomething like theſe three Conditions, ſeems to enter into this Diſquiſition. 1. The different *Diameter* of the *Orifice* of theſe *Secretory* Ducts, whereby Particles of a *Diameter*, greater than that of this Duct, are excluded. 2. The different *Angle*, which this Duct makes, with the Trunk of the *Artery*; for it is already demonſtrated, that all Fluids preſs the ſides of the containing Veſſel, and that in a direction *perpendicular* to theſe ſides; and this is evident in the *pulſation* of the *Arteries*, ſince it is, to that *preſſure*, this *pulſation* is owing. It is likewiſe evident that the Blood is urg'd forward by the Force of the Heart, ſo that the Motion of *Secretion* muſt be compounded of both theſe Motions. Now tho' this *lateral preſſure*, is greater, when the *Velocity* of the *longitudinal* Motion is ſo, yet it is not in the proportion of this *Velocity*; for this *preſſure* is always ſomewhat even, when the Fluid is at reſt, and is then in *proportion*, to the *Specifick* Gravity of the Fluid, nothing elſe being in this Fluid to produce this *preſſure*, and in a Fluid urg'd by a *Longitudinal* Direction, as the Blood in the *Arteries*, this lateral *preſſure*, is in a compound proportion of both; whence it is evident that if two Particles of equal *Diameters*, but of unequal *ſpecifick* Gravities, arrive with the ſame *Velocity*, at an *Orifice* capable of admitting either of 'em, yet they will not both paſs, becauſe their *Motion* of *Direction* is different: So that this Diverſity in the *Angles*, theſe *Secretory* Ducts make with the *Trunk* of the *Artery*, ſeems altogether neceſſary to account for the poſſible Diverſities of ſecern'd Fluids, ev'n admitting their *Diameters*, and Figures, to be the ſame. For it is not to be doubted, that the Blood is a *Hetrogeneous* Fluid, and contains parts of different *Specifick* Gravities, different Coheſions, and of different Denſities; and the ſeparated Fluid muſt be nearly *Homogeneous* to perform the uniform Functions of Life. 3. The different *Velocities*, with which the Blood arrives, at the *Orifices* of theſe *Secretory Ducts*, for ſince the *Secretions* are made in form of a Fluid, there is no poſſible Reaſon can be aſſign'd, why ſome *Animals* of the ſame Species are of a ſoft looſe Texture, and Union of ſolid Parts, and why one part of the Body is of a tender, looſe, eaſily ſeparable Texture; others of an harder, firmer, and more cloſe Coheſion, but this different *Velocity* of the Blood, at the *Orifices* of the ſeparatory Ducts. And tho' the Diverſity of the *Diameters* of theſe Ducts, is certainly that which is of greateſt *Moment* in this Affair of *Secretion*, yet it is impoſſible to account, for the *ſimilarity* of the ſecern'd Fluids from ſo *Heterogeneous* a Fluid, as the Blood is, from this alone. For ſuppoſe, (as my worthy and learned Friend Dr. *Cockburn* has very juſtly reaſoned) the *Diameters* of the Particles of *Urin*, *Gall* and *Semen*, to be as 1, 2, 3. The *Diameters* of the *Secretory* Ducts, of the *Kidneys*, *Liver* and *Teſticles*, muſt be in the ſame *Proportions*. Now tho' upon this ſuppoſition of only different *Diameters*, the Particles of *Gall* and *Semen* cannot be ſeparated in the *Kidneys*, yet the Particles of *Urine* and *Gall* may be ſeparated by the *Excretory* Ducts of the *Teſticles*, the *Diameters* of the Particles of the Fluids, being by ſuppoſition, leſs than that of the *Diameter* of the *Excretory* Ducts of the *Teſticles*. So that upon this ſuppoſition of only different *Diameters*, it is impoſſible to account, for the *Homogeneity* or *ſimilarity* of the *ſecerned*

cerned Liquors: For all the Particles of whatever kind, that are leſs than the *Diameter* of the *Secretory* Duct, muſt be indifferently ſeparated there. *Nutrition* may be perform'd by a *Secretory* Duct, ariſing from the terminating *Artery*, which carries a ſuitable Portion of the Blood, to every part to be nouriſhed, ſo that ev'ry point in the Body, muſt be the *termination* of a *Secretory* Duct; through which a proper part of the Blood is brought. The Blood in its *Circulation*, being carried into the Cavity of the *Skull*, in the Branches of *Carotid* and *Cervical* Arteries, theſe are divided into innumerable *Ramifications*, ſo as to become extremely ſmall: Their laſt Extremities after the manner now deſcribed, form a little *Gland* (all theſe little *Glands* together make the *Cortical* part of the Brain) terminating in two little Veſſels, one for carrying back as a Vein, the groſſer part of the Blood; another as an *Emiſſary* Veſſel to each of theſe *Glands*, diſtributing throughout the whole *Syſtem*, the more pure, refin'd, and ſubtile part of the Blood, (as is ſuppos'd) which is then call'd the *Animal Spirits*. All theſe little *Emiſſaries*, united together at their Origin (the *Cortical* part of the Brain,) make that Subſtance, which is called the *Medullar* part; being a Bundle of very ſmall, thread-like Channels, or

Fibres, ſome of which are carried through their proper Cavities, in the *Skull*, for the uſe of the *Organs* of Senſation; the reſt through the Cavity of the *Spine*, to be diſtributed at proper places, through the reſt of the *Syſtem*. It is not impoſſible but theſe *Emiſſary* Veſſels of the ſmall *Glands*, whereof the *Cortical* part of the Brain conſiſts, may contain a Liquor, and that this Liquor may be the more refin'd, and ſubtile part of the Blood; eſpecially if we reflect that *Nature* does nothing in vain, and that theſe *Glands* differing ſcarcely at all from thoſe others, which we certainly know ſeparate proper Liquors, but in the length of their *Emiſſary* Veſſels (the neceſſity of which in the preſent Caſe is ſelf-evident) and that the Blood Veſſels, being ſent in ſuch Numbers into the Brain, and in a much greater proportion, than to any other part of like Dimenſion, and being there form'd into the mentioned *Glands*, and theſe *Glands* ſending out theſe ſmall *Emiſſary* Veſſels, over the whole *Syſtem*. It is not impoſſible I ſay, that theſe may carry a ſuitable Liquor: For 1. almoſt the whole Maſs of Blood, in a little time is brought to this *Cortical* part of the Brain: (The moſt ſubtile, moſt ſpirituous, lighteſt, and moſt moveable part of the Blood, aſcending by the *Carotid* and *Cervical* Arteries; the groſſer, heavier and leaſt active, deſcending toward the lower parts, by reaſon of the Situation; and the greater *ſpecifick* Gravity of theſe laſt parts of the Blood.) 2. In the *Medullar* part of the Brain is often found on Diſſection, a thin, whey-like ſubſtance, which Fire hardly thickens. 3. The Nerves, are equally diſtributed all over the Body, are abſolutely neceſſary toward all Motion, Natural and Voluntary, and 4. They are the *ſpecifick Organs* of Senſibility. All which ſeem to imply that they are the containing Channels, of ſome Liquor; and then poſſibly this Liquor may be ſomething a kin, or *Analogous* to thoſe Spirits we gather from animal Subſtances, by Heat in an *Alembick*: Such as are Spirits of Sal *Armoniack*, *Hartſhorn*, *raw Silk*, or *Humane Skulls*; and what renders this Conjecture more probable, is the not altogether diſſimilar *Apparatus* in forming theſe *animal Spirits* in the Brain, from that of drawing thoſe others, in an *Alembick* by Fire; and the wonderful preſent Efficacy, theſe laſt have on the firſt; and that both are equally unalterable, by Heat and incapable of Burning. But then if we conſider on the other Hand, that theſe *nervous Fibres* ſerve equally, and adminiſter unto Nutrition, local Motion, and Senſation; this laſt Function ſeems intirely oppoſite to the Nature of a Fluid, neceſſarily acting in the other two Functions from within to without, and in this laſt from without to within. Add to this, that this nervous Fluid has never been diſcovered in live Animals by the Senſes however aſſiſted: Nor it's neceſſity evicted, by any cogent Experiment; and that *Leuvenhoecks* Experiments makes the Fibres, or the laſt Channels of this Fluid, ſo infinitely ſlender, ſmall, and ſpongy, that conſidering the reſiſtances from the ſides of the Veſſel, in ſmall tubes: It ſeems abſolutely impoſſible, any Fluid (ſuch as we have any *Idea* of) cou'd move with Velocity to anſwer the Appearances; ſo that after all, it ſeems pretty difficult to come to any certain Concluſion on either ſide. But either the Fibres, contain a pretty conſiſtent Fluid whereof they are conſtantly full, and then the leaſt drop forced into the one Extremity, will drive out as much at the other, and that inſtantaneouſly; or theſe *Fibres* are ſolid, and not pervious and ſome infinitely ſubtle Spirit pervades them, with as much Facility as it wou'd the moſt *pervious* Tubes; either of which Suppoſitions will account for the Appearances, in a groſs and general manner, which is all we can pretend to in ſuch conjectural Caſes. By the Motion of the *Heart*, through the *Emulgent* Branches, the Blood is brought to the *Kidneys*, and is there freed of its *Serum*, by their little *Glands*, and is receiv'd into the ſmall *Excretory* Ducts of theſe *Glands*, to be carried into the *Pelvis*, and thence by proper *Tubes* into the *Bladder*. Much after the ſame manner, are their proper Fluids ſeparated from the Blood in the *Liver*, *Sweetbread*, *Teſticles*, and the other *Conglobat* and *Conglomerate Glands* of the Body, ſo that it is needleſs to inſiſt on theſe.

§ XXXVI. The *Lungs* are compos'd of an infinite number of little *Lobes*, of different Figures, and Magnitudes, but ſo join'd as to leave but ſmall Vacuities between 'em. Each *Lobe* conſiſts of an infinity of ſmall *ſpherical* or *oval Verſicles*, form'd by the Coats of the ſmall Branches of the *Trachea*; ſo that they may be conſidered (when blown up) as ſo many fine *Tubes* ending in little hollow *Spheres* or *Spheroids*; upon the ſides of the *Veſicles*, the Blood Veſſels in a fine *Net-work* are ſpread. Now before the *fœtus* is brought to Light, theſe *Veſicles* lie flat upon one another, and by their *preſſure* upon the Blood Veſſels, hinder its progreſs thro' them; but as ſoon as this *fœtus* enjoys the benefit of the Air, by its weight and *elaſtick* Force, this Air ruſhes in thro' the Pipes of the *Trachea* into theſe *Veſicles*, and blows 'em up, whereby they ſtand erect upon the *Trunks* of theſe little *Wind-pipes*, and give a free paſſage to the Blood

through

through theſe Veſſels, ſpread upon their ſides. And when by the weight of the *Thorax*, and the Action of the Muſcles thereof, with thoſe of the *Abdomen*, and *Midriff*, this *elaſtick* Fluid is thruſt out of the *Veſicles*, thro' the *Trachea* in *Expiration*; theſe *Veſicles* preſſing againſt one another, and the *elaſtick* Fluid acting upon the ſides of them, and conſequently, on the Blood Veſſels ſpread thereon, ſeparate the *Globules* of the Blood, which had Room and Liberty to unite in the wider Channels of the *Veins*; and this ſeparation of theſe *Globules* of the Blood, from one to another, renders it more capable to *circulate*, in the more narrow paſſages of the *Capillary* Veſſels, divides and ſubtiliſes the groſſer parts of the *Chyle*, gives a Scarlet Colour, Fluidity and *Energy*, to the groſs, grumous and ſtagnated Venous Blood. But, if I be not very much miſtaken, there is ſtill another uſe of this natural *Function* behind, and that is to form theſe *elaſtick Globules* of which the Blood principally conſiſts. It is Matter of Fact and Obſervation, that the Blood conſiſts of a *Lymph*, which is the common *Vehicle*, ſeveral *Salts*, *Ramenta* of a thick conſiſtence, made up of ſmall Particles of carneous and vegetable Fibres from the Food, (which is probably the unform'd part of the *Chyle*, and Aliment) and theſe red *Globules*, of which we are now ſpeaking;

king; but ſometimes they are of different Colours, as *White*, *Blew* and *Purple*; theſe any Body may diſcover with an ordinary *Microſcope*. Now it's certain, that theſe *Globules* may be burſt, as in obſtructions; or may be all exhauſted, as in violent *Hæmorrhages*, and yet be all recovered and recruited again; wherefore it is of neceſſity, that theſe *Globules* muſt be form'd ſomewhere in the Body from the *Chyle*. And ſince it's certain that they are not ſolid *Particles*, both by ocular inſpection and touch, and by the neceſſity they are under to change their Figures into oblong *Spheriods*, in the *capillary* Veſſels, as alſo from their Colour, and that *Acids* do actually deſtroy their Figures, and coagulate theſe *Globules*; it is not improbable, they may be little bubles, blown from the viſcid part of the *Chyle*, by the force of ſome more ſubtile *Elaſtick Aura*. Now no Place in the Body, but the *Lungs*, can ſo conveniently afford this *elaſtick* Fluid; and this may be the reaſon why the *Chyle* enters into the *Veins*; and theſe too only, which are juſt returning immediately to the Heart, to be ſent into the Lungs. For ſince in our groſs *Element* of Air, there is conſtantly lodged, a finer *elaſtick* Fluid, which is the principal Agent, in all the ſubtile Effects commonly aſcrib'd to the other, tho' the groſſer *Element* cannot.

not, yet this finer Fluid, by that vaſt Force uſed in *Expiration*, may be thruſt in thro' the ſides of theſe *Veſicles*, to the Blood Veſſels; and ſeeing theſe Blood *Globules* muſt be generated ſomewhere, and ſince there is no part in the Body, this ſubtile *elaſtick* Fluid can ſo conveniently be ſqueez'd with ſufficient force, to get through the ſides of the Blood Veſſels, but in the *Lungs*; it ſeems not unlikely, that theſe *Globules* are form'd there after this manner: The *viſcous* part of the *Chyle* being by the ſhorteſt and ſafeſt courſe poſſible, brought into the returning part of the Blood, is ſent from the right *Ventricle* of the Heart to the *Lungs*, and is ſpread upon the ſides of the *Veſicles* thereof, in little fine *Tubes*, this fine *elaſtick* Fluid being ſqueez'd, in the Act of Expiration, through a *Pore*, continued through the *Veſicle* of the *Lungs*, and the ſide of the Blood Veſſels, is forc'd into the *viſcous* part of the *Chyle*, which is running by in the *Serum*, and by its *perpendicular preſſure* upon the ſides of that Cavity it forms, produces a ſmall little *buble*, of a certain magnitude, and thickneſs of Shell, from whence it has its Colour, and by the force of the ſucceeding Fluid, this little *buble* is broken off from the *Pore*, and carried along the *Artery*, and the *Coheſion* of the parts of the Shell of this *buble*, being greater than the force from without, whereby the thin *Serum* acts upon it, it is preſerv'd in its figure in all the various Motions of the compound Fluid of the Blood; and if it happen that theſe little *bubles* ſhou'd be burſt, (as they moſt certainly are by a thouſand Cauſes) when ever they come to the *Lungs*, they are new-form'd again, whereby the *circulation* is rendred conſtant and uniform. For ſhou'd theſe *Globules* be all deſtroyed, there muſt of neceſſity ariſe a general Obſtruction in all the *Capillary Arteries*. The manner of theſe Production of the little *bubles*, in the Blood by the *elaſtick* Fluid, forc'd through the ſides of the *Veſicles*, and Blood Veſſels in the *Lungs*, is ſo obvious, that I ſhall inſiſt no farther upon it, ſince every body may ſee an Inſtance of the ſame Nature, in mixing Oil with Vinegar, the Subſtance of which Mixture, when view'd, but with an ordinary *Microſcope*, appears to be nothing but an *infinity* of ſuch like little *bubles*, form'd by the immiſſion of the Air, and Vinegar, into little Shells of Oil. But from this Principle, ſome of the deſpair'd of Appearances, in the *Animal Oeconomy*, may be made eaſy; and ſome difficulties about the Cauſes of Diſeaſes, and the manner of the Operation of *Medicines* vaniſh. And this makes it look the more like truth, Nature being frugal in her Principles, but various in the Effects thence ariſing. But it being both foreign to my Deſign, and unfit for the Limits I have preſcrib'd to my ſelf, to deduce *Corollaries* ariſing from a Conjecture only: I ſhall therefore proceed to repreſent ſome others of the Animal *Organs* and *Functions*, in the beſt manner I am able.

§ XXXVII. A *Muſcle* is a bundle of *Veſicular* Threads, or of ſolid *Filaments*, involved in one common *Membrane*, one of whoſe Extremities is faſtned to an Immoveable, the other to a moveable part of the Body; which by the inflation of the *Veſicles*, or ſwelling and hardening of theſe *Filaments*, are brought nearer one another and ſo become the proper *Organs* of Motion. When a *Muſcle* by boyling, waſhing, and cleanſing, is duly prepar'd the Texture of theſe *Veſicular* Threads, or ſolid Filaments become more evident and perſpicuous. If the laſt Fibres of *Muſcles* be *Veſicular*, then probably they may not be unlike a ſtring of *hollow Beads*, and may be originally hollow Tubes, ſtraitly ty'd together, by tranſverſe *Filaments*, ſo as to form theſe little *Bladders*; with which ſmall Branches of Blood Veſſels are ſo interwoven, as that the Mouth of a little Artery, and Nerve, gapes into the Cavity of theſe *Veſicles*: Both which are ſo abſolutely neceſſary to the Action of a *Muſ-*

cle, that either being tyed or cut, at the entry of it, no Action or Motion can enſue.

If *Muſcular Fibrils*, be *Vaſcular*, then we may reaſonably ſuppoſe all the *Carneous* Fibres, which are neceſſarily requir'd for Motion, to be *Veſicular*, after the manner I have now deſcribed them; and that the *Nervous Fibres*, are *Cylindrical Tubes*, for conveying the Nervous Juices. The two Extremities of the *Muſcle* which are called *Tendinous*, were generally thought, to be the ends of the *Carneous* Fibres more cloſely compacted, ſo as to admit but few Blood Veſſels or Nervous Channels. But Mr. *Lenvenhoeck*, by his latter Obſervations on them, ſeems to think them of a different Subſtance from, and to be diſcontinued with, the *Belly* or fleſhy part of the *Muſcle*. If the *Muſcular Fibrils* be Vaſcular (as I have ſaid) then the uſe of their *Veſcular Cells*, may be for receiving the *Arterial* and *Nervous* Juices, that by their Action upon one another, they may be ſwell'd ſome how, ſo as to ſhorten the Length of every *Fibril*, and conſequently to bring the Extremities of the *Muſcle* near one another, which is the proper Action of the *Muſcle*. But whether the ſwelling of the *Veſicles* be owing to an *Exploſion*; to an inſtanteous *Fermentation*; to the greater *Attraction* of the Nervous Fluid on the Blood Globules, than thoſe have upon one another; or to the mere *Mechanical* Action and Preſſure, of the Nervous Juice on the arterial Blood already filling the *Veſicule*. Or laſtly, whether the *Fibrils* are not in themſelves ſolid, (and not Tubular Filaments,) contracted by a ſubtile Spirit pervading their ſolid Parts, whoſe *Law* and *Action*, is, or is never to be determin'd, I will not take upon me to decide. But if I conjecture right, the Nature of *Life*, *Light*, and *Animal Motion*, will be an eternal Reproach, to *Mechaniſm* and Humane Invention. The ſureſt Method to arrive at any certainty, in ſuch intricate and obſcure Subjects, as ſome of thoſe Animal *Functions* are, is to go no further than *Anatomy* and *Occular* Inſpection will direct us; and ſince it is not as yet poſitively Demonſtrated, whether the *Animal Spirits*, be a Fluid contain'd in the *Nervous* and *Membranous* Fibrils, as hollow Tubes, or if they are only a *ſubtile Spirit* or *Aura* perwading theſe, as ſolid Filaments. Nor whether the laſt and ſmalleſt Muſcular Fibres be *Veſicular*, or not, I cannot ſee ſufficient materials, to found any juſt Explication of this Animal Function, upon.

§ XXXVIII. The Fluids of the Body are principally propell'd, by the Action of the Heart, and the *elaſtick* Force of the *Fibres* of the containing Veſſels. Now the Heart is a *Muſcle*, like other *Muſcles*, conſiſting of ſeveral Orders of fleſhy *Fibres*, of different Directions, it has two little *Ears* and as many *Ventricles*, which are Cavities for receiving or holding the Blood, as it comes from the ſeveral Veſſels, or is to be driven to different Places. The *Fibres* of this *Muſcle*, act as thoſe of other *Muſcles* may be ſuppos'd to do, for by the winding and ſpiral Direction of its ſeveral Orders of *Fibres*, the Cavities of the *Ears* and *Ventricles* are leſſen'd or conſtring'd. And it is obſervable that all the *Muſcular Fibres* of the Coats of the Veſſels, act after a different manner from the Nervous or *Membranous* Coats, the firſt ſeem to act by the aſſiſtance of ſome foreign Fluid, *Spirit*, or Principle. But the *Membranous* Coats, meerly by their own *Elaſticity*, being ſtretch'd firſt by external Violence. Thus the ſides of all *Membranes* are bent or preſs'd outward by ſome included Fluid, but reſtore themſelves by their own natural Elaſticity; whereas whenever a Coat conſiſts of *Fibres* of whatever kind, excepting thoſe for *Senſation* or *Nutrition*, it is a ſure *Indication* that this Coat acts as a *Muſcle*; for Nature does nothing in vain, and wou'd never have diſtinguiſh'd a Coat into *Fibres*, but for *Muſcular* Action, when a continued *Membranous*,

nous, or *Tendinous* one, is more capable of acting by its own *Elaſticity*. So that the Nature of the Coats, and of their conſtituent *Fibres*, of the Channels, being known, together with the Range and Direction of theſe *Fibres*, it is eaſy to know the manner of their operating upon the included Fluid. The Coats of the *Gullet* are three, the outermoſt *Membranous*, the ſecond fleſhy and *Muſcular*, turning obliquely from the uppermoſt end of the *Oeſophagus* to the *Stomach*; the third, is tendinous and *muſcular*, of white ſlender *Fibres* diverſely interwoven. The *Stomach* has four Coats, the innermoſt is Carpet-like, of white ſhort tendinous *Fibres* ſtanding *perpendicular* upon the next Coat, which is *nervous* and extremely ſenſible; the third is fleſhy and *Muſcular*, of ſtraight and circular *Fibres*; the fourth *Membranous* from the *Peritonæum*. The *Guts* conſiſt of three Coats, the innermoſt is of the ſame nature with that of the innermoſt of the *Stomach*, the ſecond is of two Orders of *Muſcular Fibres*, *Longitudinal* and *Spiral*, the third is common and *membranous*, ariſing likewiſe from the *Peritonæum*. The *Nerves*, as I have before ſaid, are a bundle of fine, ſmall, and ſlender *Pipes*, or Threads, wherein the Animal Spirits, or ſomething Analogous to what is called by that Name, are treaſur'd up for the Expences of Motion and *Senſa-*

Senſation; they ariſe from the *Glands* of the *cineritious* part of the Brain, and are terminated in all the points of the Body; ten pair deſcend immediately through proper Holes of the *Skull*, and ſerve the adjacent Parts, and particularly the *Organs* of four of the Senſes; the reſt in a large bundle, are let down by the Cavity of the *Vertebræ*, and at fit Places are ſent forth to actuate the ſeveral inferior parts of the Body. The *Arteries* have three Coats, the outermoſt is a fine Web of *Nerves*, and Blood Veſſels, for the nouriſhment of theſe other Coats, and for the *Muſcular Action* of the intermediate one, which is made up of ſeveral *ſtrata* of *Spiral Muſcular Fibres*, according to the bigneſs of the *Artery*. The third is a cloſe tranſparent *Membrane* very ſtrong and compact, to keep in the Blood which otherwiſe upon the dilatation of the *Artery*, wou'd tear the *Muſcular Fibres* aſunder. The *Veins* have the ſame Coats with the *Arteries*, only the *Muſcular Spiral Fibres* are thinner, becauſe of the leſſer force of the Blood againſt the ſides of the diverging *Veins*, than thoſe of the converging *Arteries*. From this general account of the ſtructure of the *Veſſels*, their Actions upon the incloſed Fluid may be eaſily underſtood, the ſhort erected *Fibres* ſerve for the attrition of the *Aliment*, and for ſtraitning the Cavity of the *Guts* and *Stomach*; the *oblique* Fibres, which make but few turns ſerve to propagate gently the included Fluid, the *Longitudinal* ones to move the Veſſel, and the included Fluid, up or down in a direction *parallel* to its length, by encreaſing this dimenſion and thereby leſſening the other, *i. e.* the tranſverſe *Diameter*; the *Spiral* ones by ſqueezing it tranſverſely, and ſo encreaſing it in length or leſſening it in breadth. Thus the Blood being puſht by the contraction of the Heart into the *Arteries*, diſtends their Coats along their whole length, 'till the force of the natural *Elaſticity* of the *Membranous* Coat, be equal to the force of this Impulſe; then that *Elaſticity* of this Coat beginning to act, at the ſame time the *nervous* Juice, or Spirit is deriv'd through the *Nerves* by this dilatation of the ſmall *Arteries*, among the *Originating Nerves* in the Brain, and ſo brings the *Muſcular Fibres* into Action. And both theſe Forces acting at once, propel the Blood in a continued Stream, through the uninterrupted Channels of the *Veins* and *Arteries*. And the impulſe of the Heart, propagated only by the *Membranous* Coat, is that which when felt, is call'd a *Pulſe* or *Pulſation* of the *Artery*.

§ XXXIX. All *Senſation* is perform'd by the immediate Action of the finer and more fluid parts of Bodies, upon the *Organs* of

Senſe; the Impulſe communicated by theſe ſubtile parts of Bodies, upon the *Organs* fitly diſpoſed, is through them tranſmitted to the *Nerves*, appropriated and contriv'd for ſuch a Senſe, and through them to the Brain. Thus in *Viſion*, the *Light* reflected from the Surfaces of Bodies, is tranſmitted thro' the *Humours* of the Eye, and congregated upon the *Retina*, in the ſame manner it was reflected from the Body, and thereby an Impulſe modified after a certain manner, ſtrikes the *Filaments* of the *Optick Nerves*, which convey this Impulſe to the Brain. In *Hearing*, the Sound after diverſe Modifications, in its paſſage through the *Meatus Auditorius*, ſtrikes on the *tympanum*, which moving the Bones of the Barrel, and they the incloſed Air of the *Labyrinth*, the *Auditory Nerves* there, are mov'd, after the ſame manner they wou'd have been, had the common Air acted upon them, with the Advantage of a better qualified and gentler Impulſe than they cou'd have had otherwiſe. In *Smelling*, *Taſting*, and *Touching*, the *Effluvia* and more ſubtile parts of Bodies, act immediately upon the *Nerves* themſelves, and they communicate this Action to the Brain: So that in ſome manner, all *Senſation* is nothing but *Touching*, ſeveral ways diverſified. *Generation* is nothing but *Accretion*, for it is beyond all doubt, that all *Generation* is from a preceding little *Animal* lodged in the Male. I have demonſtrated the *Mechanical* production of *Animals*, to be impoſſible and unconceivable; there is nothing in an *Animal* but an *infinity* of branching and winding Channels, and their contain'd Fluids, and no Diſpoſition or Arrangement of either, can produce an *Animal*, ſince all the parts muſt be form'd together, in order to make a complete *Animalcul*; for it is not in Animals, as in Houſes, or other humane Performances, where the parts can ſubſiſt ſeparately and be fram'd one after another; but towards an Animal, the whole *integral* parts at leaſt, muſt have been form'd at once: Since we are very ſenſible there is not one *noble* Part, that an Animal can be without, but with the immediate danger of the whole Compound. And to have the *Animal* compleat and perfect in its kind, there is not a ſingle Veſſel, or *Organ*, how inconſiderable ſoever, that muſt not have been compleatly formed and fitted up, all and ſundry, at one and the ſame inſtant of time, ſince the Circulation of the Fluids, and the natural Functions of the whole, do in a higher or lower degree, depend on the Integrity and Perfection of each ſingle part. We find ſome little *bubles*, or Blood *Globules*, may be form'd out of the *Chyle* in the Veſſels, and one kind of Liquor may be ſeparated from another, out of the Blood in the *Glands*, and theſe are all the Productions an *Animal* is capable of, which can never reach to that wonderful Number, and Diſpoſition of parts, an *Animal* conſiſts of. Now, ſince there is no neceſſity to think *God Almighty* is confin'd to a new Creation, in ev'ry *Generation* of an *Animal*, and that theſe *Animals* themſelves are conſpicuous in all Male Seeds hitherto examin'd, it is plain that they muſt have been all created at once; and lodg'd in the Loyns of the Original pairs of all the *Species* of *Animals.* Likewiſe the Fluids, if they did not move in the Channels of theſe ſmall *Animals*, wou'd corrupt and deſtroy their containing Veſſels. It's evident then that they muſt *circulate* after a manner proper to themſelves; tho' doubtleſs the *Velocity* of their Motions is perfectly accommodated to the ſmallneſs of their *Bulk*, and the ſlenderneſs of their ſolid parts; we ſee an Image of this ſlow and low kind of Life in *Swallows*, *Inſects*, *Vipers*, and other *Reptiles* in the Winter, and in almoſt all younger *Species* of Animals, and even in adult Animals of the rational kind, a Nervous Diſtemper has continued them long alive, in a kind of a Lethargick Drowſineſs without Food or Motion, and without the common Expences of Life.

But

But ſince theſe Fluids cannot move, without ſome ſmall inſenſible *Evacuations* and *Secretions*, this Loſs muſt be repair'd ſome way or other. Wherefore, it is not improbable they may lurk ſomewhere in the Male, in ſome proper Place, 'till they be fit to be carried off in the ſoft and tender Fluid of the *Semen*, to be afterwards lodg'd in the Female; where they are fitted with Accommodations, ſuited to this Degree of Growth and Perfection, 'till they arrive to the next Period of their Lives; *viz.* to bear the *Light* and the *Air*. We are certain that the *Seeds* of *Plants* are nothing but little *Plants*, perfectly form'd, with Branches and Leaves duly folded up, and involv'd in *Membranes*, or ſurrounded with *Walls* proper to defend them in this tender Eſtate, from external Injuries; that the manner of the *Generation* of *Vegetables*, is perfectly *Analogous* and Conſonant (as far as their different Natures and Circumſtances will permit) to this propoſed manner of the *Generation* of Animals. And that *Vegetation* is only the unfolding and extending of theſe Branches and Leaves, by the Force of Juices rais'd by Heat, in the ſlender *Tubes* of the *Plant*. We know that the Eggs of *Animals* are only an *Uterus* for a little *Animal*, furniſhed with proper Food, and fenc'd from external Injuries; and we know likewiſe that all the Effects of *incubation*, is ſupplying a fit degree of Heat and Warmth, to make the congeal'd Fluids flow, and more eaſily paſs into the nouriſhing Channels of the included *Animalcul*; and the Heat of the *Sun* or of our *Culinary* Fires, when duly adjuſted, produce the ſame very Effects with that of the *Females*. We are ſure, that all the ſeveral *Transformations* of *Inſects* and other *Animals*, are nothing but the *Expanſion* of their parts, and the breaking of the *Membranes* that folded 'em up, by the Augmentation of theſe parts; that all the ſeveral Figures and Shapes they put on, are owing to the ſeveral *Membranes* they are involv'd in. Now were there no other Argument, but the *Analogy* between the manner of the *Generation* and *Transformations* of theſe lower, and of the more noble *Animals*, it were ſufficient to perſwade any one, who conſiders the ſimplicity and uniformity of Nature in all her Works. But this, with theſe already mentioned, make it highly probable that we are all deriv'd from one *Seed*, and were once all actually in the Loyns of our firſt Parent, and have been ever ſince, growing to our preſent Eſtate.

§ XL. From this general view of the *Structure* of the parts, and of the manner how the *Animal Functions* are perform'd, ev'ry body may ſee how *wonderfully we are* *made*, how wiſely our ſeveral parts are fitted for their uſes; how juſtly our Fluids are contriv'd and diſpos'd, to make theſe uninterrupted *Circulations* wherein Life conſiſts; how ſimple, and yet how ſufficient, the Cauſes of all thoſe various Motions, (which we are in ſome manner able to diſcover) the *Animal* performs, are. It is impoſſible duly to conſider theſe things without being rapt into admiration of the infinite *Wiſdom* of the *Divine Architect*, and contemning the arrogant Pretences of the *World* and *Animal Wrights*, and much more the Productions of Chance or juſtling *Atoms*; for ſince even *Mechaniſm*, aſſiſted by ſome kind of *Art* and *Contrivance*, does ſo miſerably blunder in the Undertakings of this Nature (as we may ſee in all the *Schemes* of the *Projectors* upon theſe Heads) we may be aſſured *blind Chance* and *Jumble* cou'd never produce ſo beautiful ſimple and uniform Effects. Cou'd any of our *mechanical* Undertakers, with all their ſkill and cunning, make but an *Inſect* or a *Plant*, with the ſame Faculties and Qualities that Nature does; we ſhou'd begin to hearken to 'em. But they are ſo far from that, that the moſt exact and nice Performances of *Art*, come ſo far ſhort of the dead *Organs* of *Animals*, or the *inanimate* Productions of Nature, that a weak Eye may diſcover the vaſt Difference. Wherefore of unavoidable Neceſſity, *He that form'd the Eye muſt himſelf ſee, and he that made the Ear muſt himſelf hear, and he that endu'd Man with Wiſdom muſt himſelf underſtand*; and he that contriv'd ſo wonderfully and wiſely, and form'd ſo juſtly and exactly, all things both animate and inanimate, muſt needs *Himſelf be.*

But I proceed to make ſome reflections upon the particular Inſtances of *Counſel* and *Wiſdom* in the *Animal* Fabrick.

§ XLI. The Skin with its parts is what offers it ſelf firſt; the *Scarfskin* being uppermoſt, is compos'd of ſeveral Lays of ſmall *Scales*, which cover one another more or leſs, or lie thicker, according as it is thicker in one part of the Body than another; between theſe *Scales* the *Excretory* Ducts of the *Miliary Glands* of the true Skin open. *Lewenhoeck* reckons that about one Cuticular *Scale*, 500 ſuch Ducts may lie, and that a Grain of Sand will cover 250 of theſe *Scales*, ſo that one grain of Sand will cover 125000 *Orifices* of theſe *Excretory* Ducts. Now what a prodigious Number of ſuch *Glands* muſt there be on the Surface of the whole Body! Into ev'ry one of theſe *Glands* an *Artery*, *Vein* and *Nerve* do enter; ſo that we may gueſs how prodigious the Number of *Organs* in an Animal Body muſt be, from theſe that are viſible to the Eye aſſiſted with an ordinary *Microſcope.* Theſe *Glands* ſecern the Sweat and inſenſible Perſpiration. And of neceſſity they muſt be many, ſince *Sanctorius* obſerves, that through them fifteen Ounces weight of a Fluid paſſes in 24 Hours. Next under the *Scarfskin* are the *Papillæ Pyramidales,* infinite likewiſe in Number; they are the Extremities of the *Nerves* of the *Skin,* and ſerve more immediately for the Senſe of *Feeling,* to convey the Impulſe receiv'd, along the *Nerves* to the *Brain.* About theſe, the *Nerves* and other Veſſels make a fine *Web,* all cover'd over with a mucous Subſtance, to moiſten theſe *Papillæ Pyramidales*; and then under this the *Miliary Glands* themſelves are plac'd, protruding their *Secretory* Ducts, to the Surface of the *Scarfſkin*; upon which there are many *parallel* Lines, and theſe interſected by others, and in each interſection a Hair is planted. In the *Summer* the Skin is thinner and ſofter, in *Winter* more compact and hard, by reaſon of the heat and cold of theſe different Seaſons. The *Scales* of which the *Scarfskin* is compos'd are deſign'd to fence the *Orifices* of the *Secretory* Ducts of the *Miliary Glands,* and to hinder Objects from making too painful and exquiſite an Impreſſion on the *Nerves,* and to ſkreen them from external Injuries; the Skin it ſelf is deſign'd to wrap up the whole Body, to ſuſtain and to keep the *Papillæ Pyramidales* in their Places, and the *Miliary Glands* from being diſordered, to receive the Impreſſions of external Objects, and to be the *Organ* of the Senſe of *Touching* and *Feeling*. Now what can be more wonderfully contriv'd than this exterior part? If the *Papillæ Piramidales* or the *Miliary Glands* had been few and large, then the Intervals had been without any Senſe of *Feeling*, and ſo might have been deſtroy'd without our Knowledge, to the danger of the whole; and theſe *Intervals* had not been freed from the noxious parts, which are here thrown out of the Body by theſe *Glands*; but by their infinite Number, ev'ry point and *Atom* of the *Animal* Body is taken care of. But that which is yet moſt wonderful, is the apt proportioning this Senſe of *Feeling*, to the Actions and Impulſes of the Bodies among which we live. For had our Senſe of *Feeling* been ten or twenty times as exquiſite as it is, then we ſhou'd have been in perpetual Torment, ev'ry Hair had been a Dagger, the touch of a Feather, or of the Wing of a *Fly*, had made us cry out, we ſhou'd not have dar'd to have approach'd our Cloaths or our Beds; in ſhort, we had liv'd in perpetual Miſery; and had it been as many times duller, or more *callous* than it is, our tendereſt parts had been as inſenſible as our Hairs or Nails, and might have been torn away or conſum'd, without our Knowledge or Concern. Whereas by this nice adjuſtment of the Senſe of *Feeling* to the Impulſes and Actions of Bodies round us, we can live in indolence from the Diſturbance of the *effluvia*, and Actions of little Bodies that are neceſſarily in Motion; and we feel ſenſibly enough, to hinder us from hazarding the Ruin of our Fabrick. And univerſally indeed in all *Animals* whatſoever, this Senſe is adapted to the Circumſtances wherein they live, which is a notable Inſtance of *Council* and *Deſign* in the formation of the Parts. And it is worth noticing, that this Senſe of *Feeling* is rendred more exquiſite and ſenſible, or more dull and imperceptible, as it is more or leſs uſed; for it is highly probable, that the *Scales* which compoſe the *Scarfskin*, and guard the *Organs* of this Senſe from being violated, do ariſe from the *preſſure* of touching Bodies upon the Mouths of the *Superficial* Veſſels at different times, by which ſome drops of a viſcid Fluid is forc'd out, which there drying and hardning, become a ſmall *Scale*; and therefore the oftner the Mouths of theſe Veſſels are preſs'd upon, or the oftner we uſe the *Organs* of *Touching*, the more of theſe *Scales* are form'd, and the Skin becomes the thicker, and ſo a *cal-*

louſneſs grows upon it. And conſequently, the more moderately we uſe the Pleaſures of Senſe the more lively and ſenſible they are, and the more immoderately we uſe theſe Pleaſures, the leſs they are ſo; which is a wonderful wiſe Contrivance of the *Author* of *Nature*; for were it otherwiſe, ſo diſtracted is the moſt part of Mankind, that they wou'd certainly deſtroy themſelves, ſince we ſee where there is both Sin and preſent Puniſhment, they are not kept from Exceſſes that way.

§ XLII. Having already ſhewn the wonderful yet ſimple ſtructure of the *Muſcles*, I have little more to add upon that Head. For tho' ev'ry ſingle *Muſcle*, of which there are about 446 in a Humane Body, either in its *Figure*, *Situation* or *Inſertion*, has ſomething that ſpeaks *Deſign* and *Council*; yet ſeeing *Borelli* has written a whole Book to ſhew this, and to inſtance in all the Particulars, were to tranſcribe it, or to write a whole *Syſtem* of *Myologie*, I ſhall refer my Reader for his full Satisfaction in this Affair, to that learned and ſurpriſing Book *De motu Animalium*, and ſhall only ſuggeſt a few Inſtances. 1. Then the manner of the Diſpoſition of the *Muſcles* of the *Fingers* and *Toes*, is admirable. We know that for the uſes of Life, theſe

Muſcles were to be ſtrong and large, that that they might be ſufficient for the various, and forceable Motions of theſe *Organs*; now had they been ſituated near or about theſe Parts, they wou'd have altogether diſturb'd their Motions, and made theſe Places ſoft and ſpongy, and conſequently unfit for graſping and going: And to avoid this, the *Infinitely wiſe Author of Nature*, has plac'd them at a conſiderable diſtance from theſe *Organs*; and that ev'n there, they might not in bending the *Arm* or *Leg*, riſe up and fill thoſe Places with their *Bodies* or *Tendons*, he has ty'd them to the Bones by *Annular Ligaments*; and alſo that one *Tendon* might not be interrupted in its Courſe by another, he has ſlit ſome, that others might paſs through them undiſturb'd. This is ſuch a wonderful Inſtance of Wiſdom and Deſign, that none can paſs it over without Admiration. 2. It is very obſervable that in *Muſcular* Motion the Expenſe of *Animal Spirits*, is not in Proportion to the Labour the *Animal* is at. Mr. *Bernoulli* in that *curious Meditation* about *Muſcular* Motion, printed in the *Acta Lipſiæ* 1694, has demonſtrated (for whatever be in his *Theory*, yet there is certainty enough in his general Conſtruction of a Muſcle, to bear out this Obſervation) that the Expenſes of *Animal Spirits*, are in a much leſs Proportion,

tion, than the elevated Weights; for ſuppoſing the *Animal Spirits* expended, to be as 8, then a Weight four times as great, as when they are but as 5, may be lifted. So that when the *Animal Spirits* are but as 5 to 8, the Weight ſuſtain'd by 'em ſhall be as 1 to 4. And the like of the other Proportions of the *Animal Spirits*; eſpecially the Difference becomes moſt ſenſible between theſe *Animal Spirits* and the ſuſtain'd Weights, when theſe *Spirits* are expanded in greateſt Quantities. Now what a wonderful wiſe Contrivance and *Compendium* of Nature is this? Here in great Labour, the *Animal Spirits* which are the Life of the Blood, *which is it ſelf the Life of the Animal*, are ſav'd as much as is poſſible; ſo that a Man who is obliged to hard Labour, is not reduc'd to the neceſſity of having twice or four times as much Victuals, as one that is under no neceſſity to Work. We all know that the Spirits are the moſt precious things in all the *Animal Body*, by which we move, and our Blood *circulates*, *i. e.* we live; by which all the Pleaſures of Life are reliſhed, and all *Senſation* perform'd, by which we have that Livelineſs and Agility, that Chearfulneſs and Tranquility, that actuates all our Enjoyments; and without which, we are languid, and dull, unactive, and thoughtleſs. Now this, ſo neceſſary and uſeful a Subſtance, was to be ſav'd by all means poſſible, and agreeable to the neceſſities of Life, and we ſee the wiſe Author of Nature, has taken wonderful Care, that no Expenſes ſhou'd be made therein that cou'd be avoided. 3. What a ſtrange variety of Motions are our *Organs* capable of? There is no poſſible one, that might be uſeful to us that we want, and how wonderfully is the whole *Machin* adjuſted? For our erect Motion, the Center of Gravity is ſo diſpos'd, as to fall, by a Line drawn from it to the Center of the *Earth*, always in ſome part of the *parallelogram* form'd by the outer ſides of our Feet, and two Lines drawn by our Toes and Heels, by which means we are kept from tumbling: And if at any time we chance to throw this Line without that Space, and ſo be in hazard of falling, our Arms, and the various Motions of our Head, and Breaſt, immediately bring it back within that Space. Thoſe *Animals* that are deſign'd for flying or ſwimming on the Surface of the Water, have all their ſtrongeſt *Muſcles* upon their Breaſts, whereby they are kept in the fitteſt Poſture for ſwimming or flying, the *Center of Gravity* being ſo diſpoſed as they are thereby enabled very eaſily, to keep their Heads above Water. And in thoſe *Animals* that live within the Surface of the Waters, there is a Bladder fill'd with Air, which has a *Duct* open to the outward Air on the Surface of the Water, whoſe *Orifice* is endow'd with a *Muſcular Sphincter*, by which they let out and take in the *Air*, to render them *Specifically* lighter or heavier, than the Fluid they ſwim in, and ſo ſink or emerge as their Occaſions prompt them, or as they paſs to a *Specifical* lighter or heavier *Element*; for by taking in more *Air*, they become lighter than they were, and ſo neceſſarily emerge, and by letting out ſome, they become heavier, and ſo ſink. And it has been obſerved that Fiſhes have got up to the Surface of the Water meerly to change and alter the *Specifick* Gravity of this *Air*. And this Bladder is commonly full of *Air*, which is under ſome Degree of Condenſation, from the *preſſure* of the *Muſcular* ſides thereof; ſuch to wit, as renders them in an *Æquilibrium* without any Pain, with that kind of Fluid they live moſt in, and they commonly alter their *Æquilibrium*, by the Compreſſion or Expanſion of this Bladder, which being cut out, the Fiſh ever after, either ſwims on the Surface or ſinks to the Bottom. Birds and Fowls that ſleep, reſting on one Foot to eaſe the other, naturally lay their Heads under their Wings, that ſo the *Center* of the *Gravity* of their whole Body, may fall upon the Foot they ſtand on, and the *Animal* be preſerv'd from overturning; and thoſe Fowls that ſleep ſo on the ſmall Branches of Trees, incline a little backwards, that their Claws by the *Gravity* of their Body, without any *Muſcular* Contraction, may graſp the Branch more ſtrongly. Theſe are wonderful Inſtances of *Divine Wiſdom* and *Providence*; but thoſe who pleaſe to conſult that noble Work of *Borelli*'s, will find to their Satisfaction, a thouſand ſuch Inſtances, relating to this Head alone of *Muſcular* Motion.

§ XLIII. The Bones conſiſt of hard compacted *Fibres*, ty'd together by *Tranſverſe* ones, after the manner of the *Muſcles*; they are nouriſhed by Blood Veſſels which enter their Subſtance at ſeveral Places, which upon the compleat Growth of theſe *Bones*, are ſo ſtraightned as to admit only what is ſufficient to repair their Decays. All the conſiderably thick *Bones* are either hollow or ſpongious, and both ſorts contain an *oleaginous* Subſtance, preſerv'd in little *Veſicles*, which by the Heat of the Body, is exhal'd through the porous Subſtance of theſe *Bones*, to ſupple and anoint their *Fibres*, that they dry not, and thereby grow brittle. All the *Bones* are cover'd with a very ſenſible *Membrane* call'd the *Perioſteum*, each large *Bone*, is conſiderably bigger at the Extremities than at the middle, and that for very ry wiſe Ends and Purpoſes: For 1. Thereby the *Articulations* are made ſtronger, for had they been leſſer or equal to the middle, our Limbs had been in hazard of being disjointed upon ev'ry Occaſion. And 2. By the largeneſs of theſe *Tubercles*, it comes to paſs, that in all the *Revolution* of the joint. The *Tendon* is kept at the ſame diſtance of the *Semidiameter* of the *Tubercle* from the Center thereof, *i. e.* the Center of Motion; whereby, in the *Articulations* of the Shoulder and Knee eſpecially, the Arm and Leg, is capable of moving round, more than a *Semicircle* which by no other Contrivance poſſible, but this cou'd be obtain'd. There are ſeveral and various manners of *Articulations* of the *Bones* into one another, wonderfully fitted for the Motions of the ſeveral Members, one is like *Ball* and *Socket*, by which the *Bone* can move equally any way; as the *Thigh-Bone* with the *Iſchium*; others are by way of *Charnal*, as the *Radius* with the *Ulna*; a third are only ty'd together by intervening *Cartilages*, as the *Vertebræ* of the Back. Now all theſe different *Articulations* are from the Neceſſity of the *Situation*, or Motion of theſe *Bones*. The *Bones* in order to be the moſt convenient that might be, ought to have been as light, as was reconcileable with a ſufficient degree of Strength, that the Inſtruments of Motion, might not require too great an Expenſe of Spirits, to move them, and that the *mechanical Machin* might not become a Burthen to themſelves; now the wiſe *Author* of *Nature*, has wonderfully provided for this, for he has made 'em light, by evacuating their middle Subſtance, and yet they are ſtronger by very far, than if they had compos'd one ſolid *Cylinder*; for *Galileo* has demonſtrated, that of two *Bones* of equal lengths, and of equal Number of *Fibres*; the Strength of the one is the Strength of the other, as their *Diameters* are; ſo that a hollow *Bone* of a double *Diameter*, to a cloſe one of the ſame Number of *Fibres*, is as 2 to 1, or the firſt is twice as ſtrong as the ſecond. This is moſt conſpicuous in thoſe *Animals* that are form'd to fly; it is wonderful, how light and yet how ſtrong, the Quills of their Feathers and their *Bones* are, and this wonderful wiſe *End*, cou'd no otherways be obtain'd but by this Contrivance. *Borelli* hath ſhewn that theſe *Bones* are ſo many *Vectes*, of which the Center of the *Articulation* is the *Fulcrum*, the *Tendons* are the *Ropes*, by which the *Vires Motivæ* of the *Muſcles* elevate, and move any weight, or overcome any Reſiſtence. There is a wonderful, and exactly nice *Geometry* uſed by Nature in the Figure, Connexion, Order, and Motions of theſe

Pillars of the Body, and of their Cover the *Muſcles*; it were alone a ſufficient Work, to ſhew all the *Neceſſities*, the wiſe *Contrivances*, and prudent *adaptions* of theſe admirable *Machines* for the benefit of the whole. I ſhall Inſtance only in two or three Particulars, and then proceed. 1. Then, what can be more wonderfully contriv'd than the *Back-bone*, had it been all of one entire *Bone*, without *Articulations*, we cou'd not have ſtoop'd or turn'd, but have gone forward like a Poſt or Pillar; had it been compos'd of a few *Bones* only, then the *Articulations* of theſe *Bones* in bending our Backs, muſt have made a large *Angle* upon their innermoſt edges, and ſo the *Spinal Marrow*, which ſends *Nerves* to all the Inferior parts of the Body, had been in hazard of being bruis'd at every ſtooping; and conſequently all the inferior Parts, had been in perpetual hazard of being depriv'd of the Inſtruments of their Motions; beſides that the whole wou'd not have been pliable, for the various Poſtures we have occaſion to put our ſelves in. If it had conſiſted of various *Bones* without intervening *Catilages*, we ſhou'd have had no more Benefit by it, than if it had been entire without *Articulations*, or had theſe *Articulations* been after the manner of ſome others of the *Bones*, we had not been capable of theſe Varieties of Motions that we now are, if each *Vertebra* had had its own proper *Cartilage*, the

Articulations might have been eaſily disjointed. So that we ſee, the Contrivance of this Hulk as it were, of the Body is the beſt that can be imagin'd; for by theſe many and ſmall *Articulations* upon ſomewhat plain and ſmooth Surfaces, ty'd by a common *Cartilage*, the Back, for the Security of that *Medullary* Subſtance, that runs down its *Cavity*, is bent after the manner of the *Catenarian Curve*, by which it obtains that *Curvature* that is ſafeſt for the included *Marrow*, and brings the greateſt degree of firmneſs; the oblique Proceſſes of each Superior and Inferior *Vertebra*, keeping the middle, from being thruſt backwards or forwards, to hurt the *Spinal Marrow*. Beſides, had not the *Tranſverſe Proceſſes* been ſo plac'd as they are, to keep the intermediate *Vertebra* from being thruſt backward or forward, then there wou'd have been no more reaſon why in *Inſpiration*, the *Ribs* ſhou'd have mov'd upwards and forwards, than backwards. But as they are now contriv'd, theſe *Proceſſes* force the *Ribs* to move upwards, and ſo lift up the *Sternum*, whence the *dilatation* of the *Thorax* proceeds, which cou'd not *dilate*, were there no *Tranſverſe Proceſſes*, or they otherwiſe diſpos'd. Now can there be a more manifeſt Inſtance of Council and Contrivance than this. Certainly, if infinite Wiſdom were ſuppos'd to have fram'd this part, it cou'd not have given a more pregnant Indication thereof.

2. As I have obſerv'd before, ſome *Bones* are articulated after the manner of *Ball* and *Socket*, as the *Humerus* with the *Scapula*, and that for this wiſe End, that the Arm might have all manner of poſſible Motions; but the *Ulna* and *Cubitus* is join'd by way of *Charnal*, that this *Articulation* might be the more ſtrong, for had it been after the former manner, we ſhou'd have had no Benefit thereby, for that *Articulation* of the Shoulder, takes off the Neceſſity of another ſuch here; the Hand by it, having all the Motions, that it cou'd have by another of the ſame kind, in this other *Articulation*; and we ſhou'd have loſt the Benefit of the greater Strength in this Joint. Thus we ſee, Nature in theſe Motions looſes no Benefit in the ſeveral Parts, that can conſiſt with the good of the whole. 3. Becauſe the *Tubercles* of the *Bones* of the *Fingers* and *Toes*, cou'd not be conveniently ſo large in Proportion to the middle of theſe *Bones* as they are in others, becauſe thereby in graſping or ſqueezing, theſe points of the *Fingers* which are at the *Articulations*, cou'd only come into *contact* with the Body ſqueez'd, and ſo the Action cou'd not be uniform; and by this ſmalneſs of theſe *Tubercles*, there was a hazard of bringing the direction of the Action of the *Tendons* of thoſe *Muſcles*, which contract the *Finger* and *Toes*, quite through, or very near the *Center* of *Motion*; whereby this Action wou'd have been

quite, or almoſt deſtroy'd. Now to prevent this Inconvenience, the *Oſſa Seſamoidœa* (call'd ſo from their Reſemblance to the Grains of *Seſamum*) are plac'd at the *Articulations* of theſe *Bones*, to ſerve as ſo many *Pullies*, about which the *Tendons* paſs, at ſome diſtance from the Center of the *Articulation*, whereby the direction of the Motion of theſe *Tendons*, are remov'd always at the ſame diſtance from the Center of Motion, of the *Articulation*. The ſame Artifice is us'd in the *Knee*, by means of the *Patella*; theſe are wiſe and noble Ends, which the Wit of Men cou'd not have thought of, had they not obſerv'd them.

§ XLIV. How wonderfully is the Brain contriv'd, how carefully and ſtrongly is that principal *Organ* of the Body, fenc'd from external Injuries, by a thick Wall of hard *Bone*, and two very cloſe and compact *Membranes*? What an infinite Multitude of *Glands*, are in the *Cortical* part, and of beginning *Nerves* in the *Medullar* Part, a Hundred of which do not exceed one ſingle Hair? How commodiouſly are the *Nerves*, that ſerve for four of the *Senſes*, and all the parts of the *Superior Regions*, ſent out the ſhorteſt and ſafeſt ways through proper Holes in the Head? And thoſe that ſerve the *Inferior Regions* of the Body, carry'd down in a *Bony Channel*. And it is very remarkable, that the *Veins* do not paſs out, at the ſame Holes the *Arteries* enter; for if they did, then upon any violent Motion of the Blood, or any greater Quantity thereof than ordinary, lodg'd in the *Arteries*, their *dilatation* and *pulſation* wou'd compreſs the *Veins* againſt the *bony* ſides of their Paſſage, and ſo occaſion a *ſtagnation* and *extravaſation* of the Blood in the Brain, to the deſtruction of the whole *Machin*; which by theſe different *Enteries* and *Exits* of theſe Veſſels is prevented. Theſe *Veins* alſo do not run along by the ſides of the *Arteries* in the Brain, as they do thro' all the reſt of the Body, which is alſo another wiſe Contrivance of Nature; for the *Arteries* here, were by their *dilatation* to preſs out their Juice or Spirit from the *Nerves*, into the *Muſcles* of *involuntary* Motion, which wou'd have been hindred if the *Veins* had always gone along with the *Arteries*; for theſe *Veins* wou'd have receiv'd the impulſe of the *Arteries*, and thereby in ſome Meaſure kept it from the *Nerves*. Next how ſtrongly is the *Heart* built, and with what a force does it ſqueeze out the Blood into the *Arteries*; *Borelli* reckons it equal to the force of 3000 Pound Weight, and that 350 Pound Weight of Blood, paſſes through the *Heart* ev'ry Hour. How variouſly and effectually for its end, are its *muſcular Fibres* arrang'd, and with what Judgment are its *Columns* and *Furrows* diſpos'd, for the cloſer Contraction of its *Ventricles*! its point is turn'd a little toward the left ſide, for the more eaſy aſcent of the refluent Blood in the *Cava*, for thereby like a reclining inverted *Siphon*, the left *Auricle* becomes lower than the right. All the *Auricles* and *Ventricles* have *Valves*, whereby the Blood has a paſſage in its true courſe forward, but is hindred from returning the ſame way; which wou'd frequently happen, upon the equal *preſſure* of the Blood on all Hands, and the Reſiſtance of the ſides of the Veſſels, to the Ruin of the *Animal*; which Inconvenience is entirely prevented, by this prudent Contrivance and Situation of the *Valves*. And ev'n the Figure of the *Valves* themſelves, in the ſeveral different Places, is for wiſe Ends and Purpoſes. But that which is moſt wonderful in this Affair, is the different *Structure* of the *Heart* in the *Fœtus*, from that of the ſame in adult Perſons. In the Heart of the *Fœtus*, juſt oppoſite to the Mouth of the *Cava aſcendens*, there is a Hole from the *Cava*, that opens into the *Vena Pulmonalis*, and is call'd the *Foramen Ovale*; there is likewiſe a Paſſage, which runs from the *Trunk* of the *Aorta*, to the *Trunk* of *Arteria Pulmonalis*. Now the Blood which is receiv'd by the *Placenta* from the Mother, is by the *umbilical Veins* carried into the *Porta*, from which it is ſent to the *Cava*, by a Canal which goes ſtrait from the *Trunk* of the one, to the *Trunk* of the other, by the *Cava* it is thrown through the *foramen Ovale*, into the *Vena Pulmonalis*, which carries it to the left *Ventricle* of the *Heart*, by which it is ſqueez'd into the *Aorta*, to be diſpers'd over the Body. The Blood that comes from the *ſuperior Parts* of the Body, is diverted by the *Iſthmus* of the *Cava* from the *foramen Ovale*, and falls into the right *Ventricle*, which throws it into the *Arteria Pulmonalis*, from whence by the communicating Canal, it is immediately carried into the *Aorta*; ſo that the Blood that comes from the *Cava aſcendens*, paſſes only through the right *Ventricle*, whilſt that which comes from the *Deſcendens*, paſſes only through the left *Ventricle*. The reaſon of which Paſſages, is becauſe the Blood in the *Fœtus* cou'd not go thro' the *Lungs*, their *Veſicles* by their compreſſure upon the Blood Veſſels, obſtructing that Courſe; neither indeed, did the Blood need to paſs through the *Lungs*, the *Fœtus* being nouriſhed from the Mother, whoſe Fluids had already receiv'd, all the Advantages that it cou'd reap from the Air, in her *Lungs*; but when it comes into the *Air*, and is no longer nouriſhed from the Blood of the Mother, this *preſſure* is taken off from the Blood Veſſels, by the diſtenſion of the *Lungs*, after the manner already explain'd. And ſo finding a free Paſſage through the *Lungs*, it runs no more by the communicating Canal: And ſo that dries up; and by the Current in the *Pulmonary Vein*, the *Valve* of the *foramen Ovale* is ſhut ſo, that the Blood can no more paſs that way from the *Cava*. Now how wiſely are theſe different Channels for the Blood contriv'd, for the different neceſſities of the *Fœtus*, before and after its Birth! This is a plain Indication of *fore-knowledge*, and ſuch an one as nothing but Omniſcience, is ſufficient for. And this is certainly one of the moſt convincing Proofs of *Deſign* and *Counſel*, that can poſſibly be wiſh'd for; for to provide for an Event, that in the natural Courſe of things, muſt happen a long time after, is an infallible evidence, that the thing was foreſeen, and the Proviſion deſign'd, by ſome intelligent Being. But this is not the only Inſtance of a *Precaution*, for it's evident, all the ſeveral Steps of the *Growth* and *Vegetation*, both of *Animals* and *Plants*, have been foreſeen, and fore-deſign'd, by the wiſe *Author* of *Nature*; ſeeing, different Proviſions are made, and different Circumſtances adjuſted, for theſe various Periods of their Lives.

§ XLV. What a noble piece of *Geometry* is manifeſted in the *Fabrick* of the *Eye*, and the manner of *Viſion*! Without this *Organ*, *Animals* cou'd not provide themſelves with Food, nor be forewarn'd of approaching Danger, and conſequently, cou'd not guard againſt it; without the Benefit of *Light*, the animated part of this *Syſtem*, wou'd be but ſo many *Puppets*, toſs'd up and down by Chance and Fortune, without Houſe or Habitation, and depriv'd of all the Pleaſures and Conveniences of Life. What a miſerable State wou'd it be, to be confin'd to perpetual Darkneſs, and never to behold the chearful Light? The Miſery of ſuch a Life is beyond Expreſſion and Conception: And on the other Hand, what can be more amazing, than that the Particles of Matter ſhou'd be ſo fram'd, as by their means to ſhew us the *Shapes*, *Poſitions*, *Diſtances*, *Motions*, yea and *Colours* of remote Bodies? How wonderfully muſt the ſeveral Coats and Humours of this little B*all* be diſpos'd, to tranſmit through them that fine, and ſubtile Fluid, which is emitted from *luminous* Bodies, and reflected from the Surfaces of *Opake* ones; and united on the bottom of the *Eye*. Theſe things are not only contriv'd and fram'd with ſo great Wiſdom and Skill, as not to admit of a better; but to any one who attentively conſiders them, they ſeem of ſuch a Nature as ſcarcely to allow any other Method, for it ſeems impoſſible that *Light* ſhou'd repreſent *Objects* to us, at ſo vaſt a diſtance, but by the tranſmiſſion of ſome fine Fluid, from the *Objects* upon the *Eye*. And it ſeems impoſſible that any other Compoſition of the *Eye*, ſhou'd be equally fitted for that end. The *Globe* of the *Eye* is *ſpherical*; it is compos'd of ſix *Coats*, and three *Humours*, the firſt *Coat* is call'd the *Conjunctiva*, and makes the White of the *Eye*. The ſecond *Sclerotica*, it is thick, hard, and ſmooth, *Opake* behind, but *Tranſparent* before; where it makes the third Coat call'd the *Cornea*, from its Reſemblance to a piece of *Tranſparent* Horn; it has a greater convexity, than the reſt of the *Globe* of the Eye, conſiſts of ſeveral *Laminæ*, which are nouriſh'd by ſo ſmall Blood Veſſels, as to obſtruct very little of the Light. It is of an exquiſite Senſe, that upon any touch, the Tears might be ſqueez'd from the *Lachrymal Glands*, to waſh and clean it. The fourth *Coat* is the *Choroides*, it lies under the *Sclerotica*, it hath little *Glands* which ſeparate a black Liquor, which *Tinctures* the internal ſide thereof (which is otherwiſe of a whitiſh Colour) for hindring the reflected Light from diſturbing the Pictures of Objects; this Coat has a Hole before, which it called the *Pupilla*, for admitting the Light. The fifth is the *Uvea*, which is nothing but the Circumference of the *Pupilla*; It is compos'd of circular and ſtraight *Fibres*, to contract or dilate, according to the ſtrength or weakneſs of the Light; for when the Light is too ſtrong, the *circular Fibres* contract the *Pupilla*, that their Force hurt not the *Eye*; and when it is weak, the ſtraight *Fibres* dilate it, to let in more Rays, for the more diſtinct Viſion. On the inſide of the *Uvea* from its *Circumference* which joins the *Choroides*, riſes the *Ligamentum Ciliare*, by which the forepart of the *Eye* is preſs'd outward, and the *Retina* backward, or the *Axe* of the *Eye* lengthned, at the approach, of too near Objects. The ſixth *Coat* is the *Retina*, which covers like a Net the bottom of the *Eye*, it is only a fine expanſion, of the *Fibres* of the *Optick Nerve*; upon this Coat, the Pictures of Objects are fram'd. The firſt Humour is call'd the *Aqueous*, it lies immediately under the *Cornea*, it is thin and liquid, and of a ſpirituous Nature, inſomuch that it will not freeze in the greateſt Froſt. The ſecond is the *Chryſtalline*, next the *Aqueous*; it is convex on both ſides, and reſembles a double convex *Lens*; it is covered with a fine *Coat*, call'd *Aranea*. The third is the *glaſſy* Humour, it is thicker than the *Aqueous*, and thinner than the *Chryſtalline*, it gives a *Spherical* Figure to the *Eye*, upon its back part, is the *Retina* ſpread, which it keepeth at a diſtance from the *Chryſtalline* Humour, requiſite to receive the diſtinct impreſſion of Objects. The *Optick Nerves* are inſerted in the inſide of the *Optick Axes*, whereby the middle point of every Object is diſtinctly ſeen, for the Center of the Inſertion of the *Optick Nerve* is inſenſible, as Monſieur *Mariotte* has ſhewn by Experiment. And conſequently, had the Center of the *Optick Nerves* coincided, with that of the *Retina*, the middle point of any Object, had been inviſible; but by this lateral Inſertion of theſe *Nerves*, the point of the Object which is inviſible in the one *Eye*, becomes viſible in the other; for it it impoſſible, that the Rays ſhou'd fall on the inſide of both *Eyes* at the ſame time. The light which comes from the ſeveral points of Objects, is ſo refracted (by the *Cornea* and *Chryſtalline Humour* principally) as to meet again upon the *Retina*, and there to paint in the ſame Order and Proportion, with the Object, the Image thereof, (as is evident by taking off that part of the *Dura Mater*, which covers the backſide of the *Retina*, from the *Eye* of any dead *Animal*, and then placing the *Eye* in a fit Hole, of a dark'ned Room; for looking then upon the back part of the *Retina*, we ſhall ſee through it, the Pictures of external Objects painted upon its inſide) and theſe Pictures propagated by Motion, along the *Optick Nerves*, are the Cauſe of *Viſion*. Now what can be more admirable than this ſtructure of the *Eye*; ev'ry part contributing ſomething toward its Perfection. It is ſituated in the *Head*, the moſt eminent part of the Body, next to the moſt noble and vital *Organ*, in the whole Compoſition: Either in the fore part, or the ſides, according to the neceſſary occaſions of the Animal: In *Man* it takes in but a *Hemiſphere* of Viſion, in *Birds* almoſt a whole *Sphere*, and in ſome timerous Animals, as *Hares* and *Conies*, their Eyes being ſo protuberant, and placed ſo far backwards on the ſides of their Heads, they muſt ſee a whole Sphere quite round, with the leaſt Motion of theſe *Organs*.

The *Cornea* is more *convex* than any other part of the *Eye*, by which all the Rays are gathered, to paſs through the *Pupilla*, and few of 'em loſt on the *Uvea*. The *Aqueous Humour* being thin, eaſily changes its Figure, either when the *Ligamentum Ciliare* contracts, or both the oblique *Muſcles* protrude, the Bulb of the *Eye*, to render it oblong, when Objects are too near; the *Fibres* of the *Uvea* contract or dilate the *Pupilla*, according to the Degrees of the Strength of the Light. The *glaſſy Humour* keeps the *Retina* at a due diſtance from the *Chryſtallin*, the Images are painted upon a Skin, produc'd by the Expanſion of the *Optick Nerves*, for the more eaſy conveyance of the Impreſſion to the Brain. The *Choroides* is tinctur'd black, that the Rays that paſs through it may not be reflected back again upon the *Retina*, and ſo confound the Object. The *Optick Nerves* are inſerted on the inſide of the *Axes* of the *Eye*, that the whole Object may be diſtinctly view'd; the Hairs of the *Eyebrows*, with thoſe on the *Eyelids* defend it from filth and light Bodies that ſwim in the *Air*; the continual Motion of *Eyelids*, moiſten and ſweep the *Cornea*, elſe it would dry or grow dirty; it is ſunk in a Hole, wall'd with a ſtrong Bone, to keep it from more powerful Injuries. The ſeveral refractive Virtues of the *Coats* and *Humours*, ſerve to correct the Errors ariſing from the different *Refrangibilities* of the Rays of

Light. Our Eyes are double, to ſecure both ſides from Danger, becauſe if the Objects were near, however one *Eye* were plac'd, we cou'd not diſtinctly perceive them that ſhou'd be ſituated towards the ſides of our Body, and ſo cou'd not guard our ſelves from the Dangers, thence ariſing. Beſides, we cou'd not diſtinguiſh the diſtance of Objects by one *Eye*, for our two *Eyes* are like two different Stations in *Longimetry*, by the aſſiſtance of which, the diſtance between two Objects is meaſured. As alſo, when one *Eye* is accidentally rendred uſeleſs, we enjoy the Bleſſings of this ſo neceſſary a Senſe, by the Benefit of the other. It is obſervable that the Figure of the *Chryſtallin* Humour of Fiſhes, is a great deal nearer to a *Sphere*, than that of Land *Animals*, and that becauſe of the different refractive Virtue of Water from Air, for that convexity which wou'd unite the Rays of Light coming through Air, will not unite the ſame ſo perfectly at a point, in the ſame diſtance, coming through Water. In thoſe *Animals* that gather their Food from the Ground the *Pupill* is *Oval* or *Elliptical*, the greateſt *Diameter* going tranſverſly from ſide to ſide; in thoſe that ſeek their Food on higher Places, its greateſt *Diameter* goes from the top of the Head towards the Feet *perpendicularly*; theſe two different Figures being wonderfully fitted to the different neceſſities of theſe *Animals*. Thoſe living

Creatures that by their Figure, and for other reaſons, have no Motions of their Neck, have a Cluſter of *Hemiſpherical Eyeballs* which ſend in the Pictures of Objects all around them; and thoſe that ſeek their Food in the dark, have their *Retina* coloured white, which reflects the light and enables them to ſee beſt in the leaſt light; theſe are wonderful and ſurprizing Inſtances, of *Foreſight* and *Counſel* in that Being that fram'd theſe *Organs*; but that which to me is moſt ſurprizing in this Affair, is that in all Animals, whoſe *Organs* are ſound; they ſhou'd have been ſo nicely fram'd in all the infinite poſſible Varieties over and under, as to repreſent Object at a due Diſtance, of that Magnitude that has the juſteſt Proportion and trueſt Analogy, to the Magnitude of each particular Animal. What the real Magnitudes of Bodies are, I doubt no body can juſtly tell, nor were it of any uſe to us to know, ſince their *Analogical* Magnitudes to the Magnitude of our Bodies, is all that we have any Concern about. Thus taking our own Hand, Foot, or Height for our Standard, all things about us are repreſented in a conſtant uniform Proportion to theſe, ſo that we are thereby informed of that Diſtance and Magnitude of Objects that is moſt natural and familiar to us, and is alſo moſt neceſſary for our Security and Preſervation: And the ſame is true of every other Animal ſmall, or great, thus take an *Elephant*, a *Man*, and a *Mite*,

Mite, and preſent the ſame Object to them all three, and it ſhall appear, not of the ſame Magnitude to them, but in a Magnitude in ſome ſort, reciprocally proportional to their own Bulks, that is, to the Elephant, leſs than to the Man, and to the Mite, much greater than to either, and this of neceſſity from the different Magnitudes, aud Fabrick of their *Nerves* and *viſual Organs*; and for the neceſſity of their Preſervation, and ſeeking their Food. Now we know from the Laws of *Opticks*, that had the *Retina* been remov'd farther from, or brought nearer the *Chryſtallin* Humour, or (keeping the *Retina* at the ſame Diſtance from that Humour) had it conſiſted of two *Segments* of a leſs or greater *Sphere*, the Viſion had been indiſtinct or none at all; or had the Diſtance been fitted exactly in the *Focus* of the *Chryſtallin*, but had it conſiſted of *Segments* of *Spheres*, leſs or greater, than thoſe of our *Chryſtallin Humour*, that are at preſent, we had ſeen Objects ev'n at a due Diſtance, either bigger or leſs than we now behold them, which wou'd have expos'd us to a thouſand dangerous Miſtakes; for Example, the Precipice that perhaps was not many Feet from us, might have appear'd at ſome Paces Diſtance, and we have tumbled down, ere we were aware, or the *Atom* that we now ſcarce take Notice of, wou'd have covered all our view, and hindred us from taking in any other Object; in a Word, beſides that thus we ſhou'd not have diſcovered that *Magnitude* of Objects, which has the moſt proper and fit Analogy to us, which wou'd have had a Thouſand fatal Conſequences, had our Eyes magnified Objects, any thing conſiderably, we cou'd have ſeen but a very ſmall part of them at once, and Twenty dangerous things might have been in our ways, which we cou'd not have diſcovered, but by a great deal of Pains; ſo that our progreſſive Motions, muſt have been ſlower than thoſe of *Reptils*, and then ev'ry little Particle, likewiſe, wou'd have been able to have damn'd up, and obſtructed our Sight; and had our *Eyes* diminiſhed Objects conſiderably, we cou'd have ſeen them but faintly and indiſtinctly, all minute Bodies wou'd have vaniſhed, and we might have been deſtroy'd by thoſe which we thought at a diſtance. In one Word, there are infinities of different Ways, our *Eyes* might have poſſibly been form'd, none of which cou'd have brought with it, the Advantages the preſent Structure does. Can there then be a more pregnant and convincing Evidence of the *Being* of an *infinitely wiſe* Power, who out of the infinite poſſible Varieties, of diſadvantagious Fabricks of this *Organ*, has ſingled out that only one, that was beſt; he certainly deſerves not to enjoy the Bleſſings of his *Eye Sight*, whoſe Mind is ſo deprav'd, as not to acknowledge the Bounty and Wiſdom of the Author of his Nature, in the *raviſhing* and *aſtoniſhing* Structure of this noble *Organ*.

§ XLVI. *Hearing* is the next Senſe in Dignity to *Seeing*, (for I reckon *Feeling* a general one, of which the reſt are only particular *Modifications*) without which our Lives wou'd be very Comfortleſs. It is by Means of this Senſe, we enjoy the Benefits of Converſation, and the Pleaſures of *Muſick*; and by it we are forewarn'd of thoſe Dangers, our Eyes cannot inform us of; and what can be more wonderful than that the ſame *Medium* of Air, ſhou'd ſerve us for ſo many different, yet neceſſary Uſes: By it our Vapours are ſupported, and buoy'd up to the higher Regions, to be there form'd into Snow or Rain, according to the Exigencies of different *Climates*; by it's Motion our Winds are produc'd, which ſail our Ships, and purify our *Atmoſphere*; by drawing it in we live, and our Blood is fitted to perform its *Circulations*; by it Sounds are convey'd to our *Ears*, and other Mens Thoughts to our Minds. The internal Parts of the *Ear* are theſe, 1. The *Meatus Auditorius*, which is a contorted Paſſage for the outward Air, running firſt upward, and then downward; here are many *Glands*, which ſeparate a viſcid glutinous Matter, which hinders Inſects, or any hurtful thing, from corroding the *Tympanum*, which is a ſecond principal part of the internal *Ear*. It is a thin *Membrane*, like the Head of a Drum, ſtretch'd upon a Bony Circle, behind which is the *Barrel*, in the Cavity of which there are four little Bones call'd the *Hammer*, the *Anvil*, the *Stirrup*, and the *Os orbiculare.* In this B*arrel* there are ſeveral Holes, one of which opens, behind the Palate of the Mouth, and receives Air to ſupply theſe Cavities, that have no Communication with the Air, coming in by the outward *Ear*. Next to the B*arrel*, is the *Labyrinth*, which ends in the *Veſtibulum*, and is follow'd by the *Cochlea*, which is a Paſſage reſembling a *Snail's Shell*, in it the Auditory *Nerves* terminate. Now when a Sound is propagated in *Undulations* through the Air (the *Sonorous* Body ſtriking the Ambient Air, by many repeated *Vibrations*, excites theſe *undulations* in it, after the manner any heavy Body thrown into a ſtanding Lake, raiſes in the Water, Waves in a Circle round it) theſe are gathered by the *Concha*, or external *Ear*, and carried through the *Meatus Auditorius*, to the *Tympanum* or Drum, on which beating, the four little Bones that are in the B*arrel*, are thereby mov'd; and as the Drum is ſtruck by the external Air, after the ſame manner is the internal Air mov'd by theſe little Bones; and this internal Air, thus mov'd, makes an Impreſſion upon the *Auditory Nerves*, in the *Labyrinth* and *Cochlea*; ſo that as the external Air ſtrikes the *Drum*, ſo does it move the Bones in the B*arrel*, to ſtrike the internal Air after the ſame manner; and as it is mov'd, ſo accordingly is the Impreſſion made upon the *Auditory Nerves*, and all this *Apparatus* ſeems intended, to hinder the Sound from coming with too great Violence upon theſe *Nerves*, for we find that too ſudden, and violent a Noiſe, is ſtill able to diſturb theſe ſlender *Tubes*, and ſometimes to diſorder them ſo, as to deprive us of this *Senſe*. Now how wiſely is this neceſſary and pleaſant *Senſe* contriv'd, for the Conveniences of Life! Had it been more exquiſite, than every little Noiſe had been capable of diſturbing us, the buzzing of a Fly, or the Noiſe of our own Breath, wou'd have pierc'd our *Ears* like a Peal of Thunder; and the Motion of every little *Atom* wou'd have rob'd us of Reſt; and had this *Senſe* been any thing conſiderably more dull, we ſhou'd have been in proportion thereto, depriv'd of all the Pleaſures and Advantages thence ariſing: So that it's evident our *Hearing*, is nicely adjuſted to the Conveniences and Neceſſities of Life, which is a plain Inſtance of *Deſign* in the Fabrick of this *Organ*; the ſame might be demonſtrated of the two remaining Senſes, which for Brevities ſake I muſt now omit.

§ XLVII. I have before obſerv'd, that all the Canals except the *Arteries* have *Valves*, by which their Fluids are permitted to go forward, in their Courſe, but hindered from returning back, all theſe *Valves*, opening toward the term of the natural Motion, of theſe Fluids, but ſhutting by the Preſſure of the Blood in a contrary Direction, and thereby obſtructing that backward Motion. Theſe *Valves* are viſible, not only in the *Veins* but in the *Lymphaticks*, the *Lacteals* and *Ductus Thoracicus*; and it is obſervable that this laſt *Channel* always goes up the left ſide, that by the Pulſation of the great *Artery*, upon which it immediately lyes, the *Chyle* may be propell'd upward. It is likewiſe remarkable, that all the Branches of the *Arteries* which go off, at any ſmall Diſtance from the *Trunks*, do all unite again in one *Trunk*, whoſe Branches communicate with one another, and with others, as before; and that for this wiſe End, that when any ſmall *Artery* is obſtructed, or cut, the Blood may be brought by the communicating Branches, to the Parts below the Obſtruction, which muſt have otherwiſe been depriv'd of Nouriſhment. The *Velocity* of the B*lood* in the extreme *Arteries* is conſiderably leſs, than that of the ſame at the *Heart*, or its entry into the *Aorta*, becauſe it is of theſe extreme *Arteries* the *Glands* are form'd, and by them the ſecretions are made, which as was before demonſtrated, require different *Velocities* in the Blood, to ſecern the different *Fluids* in theſe *Glands*: This Diminution of the *Velocity* is evident from the Proportions Dr. *James Keill*, (to whoſe Accurate *Compendium*, of the *Anatomy* of *Humane* Bodies, I have always had recourſe, where my Memory fail'd me) has giv'n us all the Branches of the *Arteries* to the great Trunk, whereby it appears the *Diameter* of the *Aorta*, does not bear a greater Proportion, to the primary Branches of the *Arteries*, than 5 to 7: And doubtleſs the odds is greater in the ſmaller

Branches. How frugal has Nature been in the Structure of the *Veins!* for becauſe of the leſs Preſſure of the *Blood*, againſt the ſides of theſe widening Channels, the thickneſs of their Walls is in proportion leſs, than thoſe of the *Arteries.* Beſides, that only thoſe *Veins* that run *perpendicular* to the *Horizon*, are endow'd with *Valves*, which ſtick to their Sides like ſo many Thimbles; which when the Blood preſſes back, are fill'd, and ſo ſtop its Paſſage, but are compreſs'd by the forward Motion of the Blood. Now theſe *Valves* were uſeleſs in other *Veins*, for their widening Channels, give no occaſion to the Blood to puſh backward, its Gravity acting laterally and not backward, as in thoſe *perpendicular* to the *Horizon*; the ſmall Branches of theſe *Veins*, communicate with one another, for the ſame ends and purpoſes that the *Arteries* did; and having now occaſion to ſpeak of the containing Veſſels, I cannot omit here the wonderful Contrivance of Nature in the Poſition of the ſeveral Parts of the *Fœtus* in the *Uterus*; the *Skull* whereof in the firſt part of the time of its *Geſtation* being very thin, large and only *Membranous*, the *Thorax* and *Abdomen* with the Limbs are ſo diſpos'd as to make the Head always emerge out of the Fluid it lies in, or at leaſt preſerves it in a Direction that it is ſtill upward, with its Face toward its Mother's Belly, but about the time of its Delivery the Skull thickens, and hardens, the Limbs and Members ſtretch out, and ſo the Head becomes the heavieſt place in the Body whereby it tumbles over, and acquires that Poſture which is fitteſt for its Delivery. Theſe are ſignal Inſtances of Counſel and Foreſight, in the Formation of theſe *Organs* and Parts, but I haſten to a Cloſe.

§ XLVIII. Having I think ſufficiently made out that great Truth, to wit, that we are *wonderfully*

fully made, though I have pointed only at a few of thoſe Inſtances that the *Animal* Fabrick and *Oeconomy* affords, I now come to make a few general Obſervations under one Head, and ſo to put a Cloſe to this *Chapter*. It is very remarkable, that thoſe *Animals*, *Plants*, and *Minerals*, that are of moſt uſe, and advantage to us, are ſuch as will grow almoſt in every *Soil* and *Climate*, and are more productive of their kind than others, and are found in moſt Places. Thus *Iron* is found almoſt every where, *Corn* is the Product of all Soils, and Climates, while other more curious and nice *Plants* will only thrive in their proper Soils: Thus *Hens*, *Geeſe*, and *Turkies* are more Productive than *Crows* or *Jackdaws*, and *Conies*, and *Hares*, than *Foxes* or *Lyons*; thus a *Crane*, which is but ſcurvy Meat, lays but two Eggs, and the *Alka* and ſome other Sea Fowls, but one, whereas the *Patridge* and the *Pheaſant* hath Fifteen or Twenty, and thoſe which lay fewer, and are of moſt value for Food, lay oftner, as the *Woodcock* and the *Dove*. What is more admirable, than the fitneſs of ev'ry Creature for the uſe we make of him? The *docility* of the *Elephant*, ſo long employed in War, the *Inſitiency* of the *Camel*, for travelling in the parch'd and dry Deſerts, the gentleneſs of the Sheep, the Cleanneſs, Beauty, Strength, and Swiftneſs of the Horſe, whoſe Breath, Foam, and ev'n Excrements are ſweet, and thereby ſo well fitted for our Uſe and Service! How frugally has Nature avoided any uſeleſs Expence of *Organs*, when the Circumſtances of the *Animal* wou'd have rendred 'em ſo? Thus thoſe *Animals* that are ſlow of their Nature, have no very quick ſight, it being uſeleſs to ſuch, ſince their ſlowneſs allows them time to dwell longer on an Object, as *Snails* and

Moles; but theſe that are endow'd with a quicker Motion, have brisker Eyes, and a more quick piercing Sight, as *Hawks* and *Hares*. Thoſe *Animals* alſo, that have no Ears have no *Organs* for making a noiſe with; becauſe wanting Ears, theſe other wou'd be uſeleſs, as *Fiſhes* and other Inhabitants of the watery *Element*. So alſo, thoſe *Animals* which have Teeth on both Jaws, have but one Stomach, becauſe theſe Teeth render more Stomachs uſeleſs; and thoſe *Animals* that have no upper Teeth or none at all, have three Stomachs to ſupply the want of theſe Teeth; as in Beaſts, the *Panch*, the *Read* and the *Feck*; and in all granivorous Birds, the *Crop*, the *Echinus* and the *Gizzard*. A Man which has a bigger Brain in proportion to his Body than any other *Animal*, has a better and more eaſily manageable Hand; whereas a *Monky* that has little Brains, and conſequently can have no great uſe for much dexterity, has not ſo well a ſhap'd nor eaſily applicable a Hand. Theſe, and a Thouſand ſuch Inſtances of *Wiſdom*, *Counſel*, and *Meliority* in the Contrivance and Fabrick of the ſeveral *Animals*, may be gathered by any one who will conſult the Writings of natural Hiſtorians. But thoſe who will not be convinc'd by the Inſtances I have brought, that there is a God who rules *in the Kingdoms of the Earth*, who number'd all our Parts, and appointed them out their ſeveral Ends and Uſes, I am afraid will not be prevail'd upon by thoſe behind.

The End of the Firſt Part.

PHILOSOPHICAL PRINCIPLES OF RELIGION.

PART II.

Containing the *Nature* and *Kinds* of *Infinites*, their *Arithmetick* and *Uſes*, and the *Philoſophick Principles* of *Reveal'd Religion*, now *firſt* publiſhed.

By GEORGE CHEYNE, *M. D.* and *F. R. S.*

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The PREFACE

To the Second PART.

BEfore the *Reader* takes the trouble, to enter on the *Second Part*, it's fit he be appriſed of a few things, that may prevent his miſtaking my meaning, in the more difficult Propoſitions, or may eanble him to run thro' the whole with more Pleaſure.

I. The *firſt Chapter* is intended only, as an Introduction to the Two Subſequent, to the *Third* eſpecially, and for clearing up and demonſtrating in the moſt familiar and eaſy way, the Nature and Properties of *Relative Infinites*. The Foundations of the *Arithmetick of Infinites*, and the Structure built thereon, publiſhed by me in the *former Edition* of this Work, having been doubted of, or miſtaken by ſome. The whole now, I hope, is clear and unqueſtionable. I have borrowed a few things from the *Third Chapter*, for the eaſe of thoſe, who either might not have Humour and Leaſure, or might not have apply'd themſelves ſufficiently to ſuch Studies, as to be able to go quite through *that Chapter*. And yet might be content to ſee this curious Speculation eſtabliſhed here.

II. The *Second Chapter* contains many Particulars of Weight and Moment. The *Foundation* is this. The *Supreme Creator* of all Things, and the whole *Syſtem* of Creatures, from the higheſt *Seraphim* down to *Brute Matter*, are here together conſidered as it were an *Infinite Cone*, (like the *Shadow* of the dark ſide of the *Earth*, circumſcribed by the Light of the *Sun* in the empty Spaces of our *Syſtem*;) whoſe *Baſe*, is the *Supreme and Abſolute Infinite*, the Origin of the Being and Faculties of all created Things; and its *Body*, is the whole *Syſtem* of Creatures, from the higheſt *Spiritual Intelligence*; deſcending in a perpetual Subordination, and continual Scale, down to *Brute Matter*; or if there be any Creature lower than this. It is true, in this *Metaphor* or *Reſemblance*, the *Baſe* is to be ſuppoſed at an *Abſolutely Infinite* Diſtance, from the Body of the *Cone*. (as the *Sun*, whoſe Rays define the dark *Cone* of the Earths Shadow, is diſtant from the *Earth*) But then, as all the *Sections* in a *Cone*, Parallel to the *Baſe*, are ſimilar to the *Baſe* and to each other. So in this *perpetual Scale* of Creatures, conſidered in one view, together with their Creator, every *Species* and ſet of Creatures is ſimilar to the *Baſe*, and to every other *Species* and ſet of Creatures, from the Higheſt to the Loweſt, *i. e.* every *Species* and *ſet* of Creatures of a higher Order, has the great *Lineaments*, and *prominent Out Lines* of their *Baſe*, the Origin of all Being and

Perfections, more ſtrongly, clearly, and largely repreſented and expreſs'd on and by them, and every *Species* and *ſet* of Creatures of a lower Order, has the ſame *Lineaments* and Characters, repreſented and expreſs'd on and by them, but in a more Weak, more Faint, and more contracted manner. And ſince *Life*, *Activity*, and *Fecundity*, are among the moſt *Univerſal*, *Primitive*, and *Original* Qualities, of the *Baſe*, the *Source*, and *Origine* of all Being and Perfections: So every *Species* of Creatures and each individual of every *Species*, muſt in a higher or lower Degree, according to their Rank in the Scale of Exiſtence, partake of thoſe *Primitive* and *Original* Qualities. If this *Principle*, and *Foundation*, thus ſhadow'd out, may be allow'd me, and ſure methinks it is Evident, from the Nature of Things *à Priori*, from all Experiments and Obſervations hitherto made on our Material *Syſtem* of Things, *à Poſteriori*, and even from the moſt genuine and ſimple reflections of our Minds within our ſelves. Then it will follow,

I. That there is a perpetual *Analogy*, (Phyſical not Mathematical) running on in a Chain, thro' the whole *Syſtem* of *Creatures*, up to their *Creator*.

II. That the Viſible are Images of the Inviſible, the Senſible of the Inſenſible, the *Ectypical* of the *Architypical*, the *Creatures* of the *Creator*, at an abſolutely infinite diſtance.

III. That the Arguments from the *Attributes* of the *Creator*, to the Qualities of the *Creature*, with due regard to the abſolutely *infinite* diſtance, is Juſt and Concluſive, *& vice verſa.*

IV. That, as there are *Objects*, intirely oppoſite and *diſparata*, ſo there muſt be Faculties, in Intelligent Creatures, ſuited to thoſe different *Objects*, differing, according to the diverſity of the *Objects*.

V. That if *Gravitation* be the Principle of *Activity* in *Bodies*; That of *Re-union*, with their Origin, muſt by this *Analogical* Neceſſity, be the Principle of Action in *Spirits*.

VI. That *Material Subſtances*, are the ſame with *Spiritual Subſtances*, of the higher Orders, at an infinite diſtance, or that *Material Subſtances* are *Spiritual Subſtances* infinitely condenſed or contracted, ſince in the *Scale* of *Exiſtence*, the *firſt* are ſuppoſed at an *infinite* diſtance from the *latter*.

VII. That, there is ſome *Analogy* between the *Conſtitution*, Temperaments and Complexions of *Spiritual Beings*, and the known different Textures, *Elements*, and Faculties of *Material Subſtances*.

Theſe I think, as they are neceſſary Conſequences from the preceeding Principle, ſo they are the main Pillars, and ſome of the principal Propoſitions of this *Second Chapter*, which, if underſtood and granted, every thing elſe will either be eaſily receiv'd, or may be ſafely rejected, without any hazard to the main *Syſtem*.

After all, ſeeing my whole Intention and Deſign, in advancing and publiſhing theſe *Specula-*

culations, was to beget in the Minds of Men, Noble, Generous, and Magnificent Sentiments, of *God* and *his* Works, that, thereby they might be more powerfully engaged, to Love, Adore, and Serve *Him.* To convince them of the *Degeneracy* and *Corruption* of the whole Race of Mankind; of the neceſſity, of expanding and cultivating their *Superior* Faculties, by a faithful Obedience, to the Divine *Attraction* and *Drawings* in their Hearts; and thereby, of begetting in their Souls, *Charity*, or the *pure Love* of *God*, and of all his Images in a proper Subordination: All which can by no other Means be brought about, but by a careful copying after, and imitating the *Model* and *Pattern* the BLESSED JESUS has ſet us in his Life and Doctrine. I ſay ſince this was my whole end and aim, in advancing and publiſhing theſe *Speculations*. If any Perſon, ſhall think fit to contravert them, he may do it very ſafely for me. For being ſatisfied, in the Honeſty and Simplicity of my Intentions, and of the Uſe and Benefit theſe Speculations have been to my ſelf, for theſe Ends and Purpoſes. I am firmly reſolved, not to ſpend my time in idle Diſputes. If others differ with me, about the Truth and Reality of theſe *Speculations*, or their uſefulneſs to, and influence on the Ends propoſed, or are not diſpos'd to reliſh or receive them, they may let them alone or reject them, it is equal to me. All I ſhall be ever prevail'd on to do, in ſuch a caſe (ex-

cepting

cepting always, in caſe thoſe who either are my *lawful Superiors*, or whom I look on my ſelf obliged in Conſcience to obey, ſhall command otherwiſe,) ſhall be; to amend, alter, or retract, what I ſhall be perſwaded is amiſs in the future *Editions* of this Work; if it ſhall have any more.

III. The *Third Chapter* is what the *Reverend* and *Ingenious* Mr. *John Craig* ſent me about Seven Years ago, when I deſired him (being low in my Health, and otherwiſe engaged) to write me down his Thoughts on, correct or alter, what I had formerly publiſhed on this Head in the *firſt Edition* of this Work, in order to a Second Edition. I have altered or added nothing, but one *Note* before his *Additions*, and that in *Italick* Characters.

To conclude, if any Perſon, by either of the Parts of this Work, ſhall be moved to Adore, Worſhip, or Love, the *lovely and adorable Author of his Being*, (who is wonderful in all his Works, and great in the leaſt,) I ſay, if any one ſhall be wrought on thereby, to love Him more, or ſerve Him better, I ſhall have the whole reward of my Labour, having intended it ſolely for his *Glory* and the *Good* of my fellow Creatures; and having I hope, in the whole, and each ſingle part, as far as my Weakneſs and Corruption wou'd permit, diſengaged my ſelf, from all *ſiniſter* Ends, from all *Fraud*, *Malice*, *Vain-glory*. and *Hypocriſy*.

THE CONTENTS OF THE Second PART.

CHAP. I.

Of the Nature and Kinds of Infinites, of ſome of their reſpective Qualities, and of a new Arithmetick of Infinites.

THE *Introduction.* page 1

Def. I. Quantity *defin'd, and explain'd.* p. 2

Def. II. Body *defin'd and explain'd.* ibid

Def. III. *The Principle of* Activity *in Bodies, defin'd and explain'd.* p. 3

Def. IV. Spirit *defin'd and explain'd.* p. 4

Def. V. *The Principle of* Action *in* Spirits, *defin'd and explain'd* ibid

Def. VI. *The Nature of* Finitude *defin'd and explain'd.* p. 5

Def. VII. *The Nature of* Infinitude *defin'd and explain'd.* ibid

Schol.

Schol. *The Nature of* Infinite Progreſſions, *defin'd and explain'd.* p. 6
Def. VIII. Relative Infinitude, *defin'd and explain'd.* p. 7
Schol. *The Diviſion of* Relative Infinitude *into infinitely* Great, *and* Little, *explain'd.* p. 8
Def. IX. Relative Nothing *defin'd, and explain'd.* ibid
Def. X. *The Nature of* Indefinite *Quantities defin'd and explain'd.*
Schol. *The Nature and Kinds of* Indefinites *further explain'd* p. 10
Def. XI. Supreme Infinitude *explain'd* p. 12
Def. XII. Abſolute Nothing *explain'd* p. 13
Two Axioms *about the Nature of* Finitude *and* Infinitude, *and the* Meaſure *of Quantity explain'd.* ibid
Prop. XI. Quantity *may be encreas'd or diminiſh'd* in infinitum. p. 14
Two different Demonſtrations *of this Propoſition.* p. 14 and 15
Coroll. I. *The greateſt Relative,* Infinite *or Nothing not aſſignable.* p. 17
Coroll. II. *The difference between* Relative Infinites, *or* Nothings, *and* Finites *explain'd.* ibid
Coroll. III. *That Relative* Infinites *and* Nothings, *are of the Nature of unknown Quantities in* Algebra. p. 18
Prop. II. *That* Unity *divided by an* infinite Number *of* Unities *make the Quotient* Relative Nothing ibid

Coroll.

Coroll. I. *That* Unity *divided by* Relative Nothing *makes the Quotient a Relative infinity of* Unites p. 19
Coroll. II. *That a relatively infinite Number of* Unites, *multiply'd by Relative* Nothing, *makes the Quotient* Unity ibid
Prop. III. *As* Finite *in General, is to Relative* Infinite *in General, ſo is Relative* Nothing, *to* Unity. ibid
Prop. IV. *Relative* Nothing *is a real* Mathematical *Quantity, and implies the leaſt Part of the* Finite, *to which it is related or compared.* p. 20
Coroll. I. *Since Relative* Nothing *is a* Mathematical *Quantity, ſo muſt Relative* Infinite *be.* p. 21
Coroll. II. *The various Senſes, in which* Relative Nothing *is taken.* ibid
Coroll. III. *That the firſt Term in the* Series *for Relative* Nothing *is ſufficient.* p. 22
Coroll. IV. *The Senſe, wherein a Quantity's being Greater than* Infinite, *or one Relative* Infinites *being Greater than another, is to be meant.* p. 23
Prop. V. *That Relative* Infinites, Indefinites, *and* Nothings, *admit of all the Degrees and* Arithmetical *Operations that Finite Quantities are ſubjected to.* p. 24
Prop. VI. *That Relative Infinite, has no* Finite *Proportion to the* Finite, *with which it is compared.* p. 25

Coroll. I. *Relative* Infinite *in General, is to* Finite *in General, as* Unity *is to Relative* Nothing. p. 26
Coroll. II. *That a ſuperior Degree of* Infinite, *is to any inferior, as* Unity *is to Relative* Nothing, *and the ſuperior Degree of Relative* Nothing, *to the inferior as* Relative Nothing *is to* Unity. p. 27
The Arithmetick of Infinites. p. 28
Prop. VII. *That* Indefinite *Quantites are properly neither* Finite *nor* Infinite *but between both.* p. 29
Schol. *A further Explication of the Nature and Limits of* Indefinites. p. 31
Prop. VIII. *That* Space *or the Extenſion of the* Univerſe, *is a* Relative Infinite, *but of a higher Degree than Infinitely Unity.*

CHAP. II.

Of the Philoſophical Principles of reveal'd Religion.

Lemma I. *THat there is a perpetual* Analogy, *running through the whole* Syſtem *of Creatures.* p. 36
Lemma II. *That this* Analogy *is a real Demonſtration of the Exiſtence and Attributes of the* Author *of Nature, and of the* Qualities *of Things thereby diſcovered.* p. 39

Lemma III. *The* Rules *for inſtituting this* Analogy p. 43
Prop. IX. *That the* Viſible, Intellectual *and* Created Species *of Things, are* Images of *the* Inviſible Architypal *and* Increated p. 46
Coroll. I. *That the* Viſible, Created, *and* Intellectual Species, *of Things, are* Images *and Repreſentations of the Divine Attributes.* p. 47
Coroll. II. *That we may ſafely reaſon* Analogi*cally, from the Nature and Attribute of the* Supreme *Intelligent Being, to the Nature and Properties of* Finite *Intelligent Beings.* ibid
Prop. X. *That a* Mathematical *Point, and Infinite* Space, *are the Two* Limits *of Natural Things, and that neither of them is any* Part *or* Multiple *of the other.* p. 48
Coroll. I. *That a* Mathematical *Point and Univerſal* Space *are Genuine* Oppoſites. p. 49
Coroll. II. *That* Matter *cannot be Infinite, as* Space *is.* ibid
Prop. II. *That* Abſolute Nothing *upon a real Quantity alters it not.* p. 50
Coroll. *That* Abſolute Nothing *when apply'd to real Quantity any how, leaves it as it found it.* p. 51
Prop. XII. *As a* Mathematical Point *is to Univerſal* Space, *ſo is* Abſolute Nothing *to* Abſolute Infinite. ibid
Coroll. I. *That* Abſolute Infinite *can neither be encreas'd nor diminiſh'd.* p. 52

Coroll. II. *That* Abſolute Infinite *is* One, *and* Individual. ibid

Coroll. III. *That* Abſolute Infinitude *is only competible to* the Divine Nature. p. 53

Coroll. IV. *That* Univerſal Space *is the Natural Image of the* Divine Infinitude. ibid

Coroll. V. *That* Univerſal Space *may be aptly called the* Senſorium Divinitatis ibid

Coroll. VI. *That an abſolutely* Infinite *Creature, is a Contradiction.* p. 54

Schol. *The* difference *between* Finite, Relative, Infinite, *and* Abſolute Infinite, *and the* Limits *of Natural and* Phyſical *Effects.* ibid

Prop. XIII. Abſolute Infinite *is the Preciſe and Proper* Oppoſite *to* Abſolute Nothing. p. 56

Coroll. I. *Since* Abſolute Nothing *implies the utmoſt Contradiction to* Reality, *therefore* Abſolute Infinite *muſt imply Neceſſity of Being.* p. 57

Coroll. II. *Therefore the* Abſolute Infinite, *muſt neceſſarily be.* p. 58

Prop. XIV. Finitude *and* Infinitude, *when belonging to natural and created Things, imply not* Realities, *but* Modes *of* Realities. ibid.

Coroll. I. *That the* Modes of *created Things, when elevated to their ſimilar Attributes, in the* Supreme Infinite, *are in him* Realities. p. 59

Coroll. II. *That the Attributes of* Power, Subſiſtence, &c. *are different in Nature, as well as Degrees, in the* Supreme Infinite, *from what they are in Creatures.* p. 61

Schol.

Schol. *That the* Faculties *belonging to the* Rational Soul, *is compounded Intelligent Beings, are* Finite, *but thoſe belonging to their* Supreme Spirit *are* Infinite. p. 62

Prop. XV. *That the* Deſire *belonging to the* Supreme Spirit *in compounded Intelligent Beings is* Infinite, *and the moſt* Cardinal *Faculty of their Spiritual Part.* p. 67

Schol. *Shewing how this may be conceiv'd* p. 68

Coroll. I. *That ſince the* Deſire *is Infinite Nothing but the* Supreme Infinite *can adequally fill it.* p. 69

Coroll. II. *Since the* Deſire *Infinite, in it ſelf can be only fill'd with the* Supreme Infinite, *it muſt then be infinitely Happy.* p. 70

Prop. XVI. *The whole* Univerſitas Rerum *is comprehended under Faculty, its Object, and the Senſation between them.* ibid

Prop. XVII. *An intelligent compounded Being, is an* Epitome *or* Image *of the whole* Univerſitas Rerum. p. 71

Coroll. I. *From this, all the* Relations, *and Moral Duties of compounded Intelligent Beings are to be deduced.* p. 73

Coroll. II. *From this the Nature of the* Component *Parts in theſe* Beings, *and of the whole material* Syſtem *is to be deduced.* p. 75

Coroll. III. *Hence the* Immortality *of the Spiritual Part of all Intelligent Beings, and of the whole Individuals of Creatures, under one form or another is to be deduced.* ibid

Coroll. IV. *That the* Deſire *of the* Soul *toward its proper Object is, as the Infinite* Space *or* Void, *to the Divine* Plenitude p. 77

Schol. I. *That as in the* Univerſitas Rerum *all may be comprehended under* Faculty, Object, *and* Senſation, *ſo in the Material* Syſtem, *we have* Brute-Matter, Gravitation *and the Beautiful* Appearances, *and in every ſingle Body, we have* Matter, *Form, and* Congruity. p. 78

Schol. II. *An* Analogical *Repreſentation of the* Ever Bleſſed Trinity in Unity, *from the Propoſitions foregoing, in elevating the conſtant Qualities of Creatures to their* Architypal Patterns, *in the Divine Nature.* p. 79

Prop. XVIII. *That there muſt be ſome Principle of* Action *in Intelligent Beings,* Analogous *to that of* Attraction *in Bodies, and that this can be nothing but that Principle of* Re-union *with the Origine of their Beings* p. 85

Coroll. I. *Hence, the Source of* Natural Conſcience *and of all internal Motions in the* Soul. p. 88

Coroll. II. *Hence, the* Degeneracy, *and* Corruption *of Mankind is evident.* p. 89

Coroll. III. *Hence, the beautiful* Analogy *of Things is to be deduced in* Spiritual Subſtances. p. 90

Coroll. IV. *Hence, the Genuine Nature of* Moral Good *and* Evil *is to be deduced.* p. 91

Prop.

Prop. XIX. *That* Charity, *is the neceſſary Effect of this Principle of* Re-union, *when expanded and ſet at Freedom.* p. 92

Coroll. I. *Hence* Charity, *is not founded on Rewards and Puniſhments.* p. 93

Coroll. II. *Hence, the* Service, Worſhip, *and* Homage, *we owe to the* Supreme Being, *is founded intirely upon his own* Original *Excellencies and Perfections.* p. 96

Prop. XX. Charity, *or the pure Love of God and of his Images, in a proper Subordination, is the end of the* Law *and the Conſummate Perfection of* Chriſtianity. p. 98

Schol. *The Objections againſt* pure Love, *are anſwered.* p. 99

Prop. XXI. *In all* Intelligent *Beings, there muſt be different* Faculties, *fitted for the ſeveral Ranks of Beings in the* Univerſitas Rerum. p. 101

Coroll. I. *Hence, the Reaſon why the whole Man, is diſtinguiſhed into* Body, Soul, *and* Spirit, *as alſo, of the* Law of the Mind, *and of the* Law in the Members. p. 105

Coroll. II. *Hence, ſince there are* Three Predicaments *of Being, there muſt be Three diſtinct Faculties in Intelligent Creatures.* p. 106

Coroll. III. *Hence, the true Nature and Extent of the* Corruption *and* Fall *of the Humane Race is to be deduced.* p. 107

Prop. XXII. *The* Rational Soul *is not that Faculty in Compounded Intelligent Beings, which in the Order of Nature, is appropriated for the* Spiritual World. p. 108

Coroll. I. *Hence, as the* Light *of the* Sun *is the* Medium *through which Material Things are perceiv'd, ſo the Eſſential* Light *of the* Supreme Infinite, *is the* Medium *through which his Nature and Attributes are to be Underſtood.* p. 112

Coroll. II. *Hence, he who wou'd Judge of Divine Things by his* Natural Light, *muſt be miſtaken, as one who wou'd* taſte *Sounds or* hear *Light.* p. 113

Coroll. III. *Hence, the* Errors *and* Impieties *of* Spinoſa *and* Hobbes, *and the Miſtakes of Mr.* Lock *are to be diſcovered.* ibid

Prop. XXIII. *In the* Analogy *of Things, as the* Material World, *is to* Univerſal Space, *ſo is the* Spiritual World *to the* Supreme Infinite p. 116

Coroll. I. *Hence,* Material *and* Spiritual *Subſtances are both of them extended.* p. 117

Coroll. II. *Hence,* Matter *and* Spirit *are Oppoſits, in every other Quality but in that of* Extenſion. ibid

Prop. XXIV. *By the* Analogy *of Things a* Spirit *is an* extended, penetrable, active, indiviſible, intelligent, *Subſtance.* p. 118

Coroll. I. *Hence a* Material *Subſtance, is an* *infinitely condenſed* Spiritual *Subſtance and* vice verſâ. p. 119

Coroll. II. *Hence, there muſt be* Spiritual *Subſtances of all Degrees of* Rarity *and* Denſity *in a perpetual Scale.*

Coroll. III. *Hence* Spirits *of a higher Degree of Purity, by their* Deſires *Communicate with, and Penetrate thoſe of a lower, but not* vice verſâ. p. 123

Coroll. IV. *Hence the* Supreme Spirit *in compounded Intelligent Creatures, is more Pure, than the* Rational Soul, *and the firſt Penetrates the Second.* p. 124

Coroll. V. *Hence the* Supreme Spirit *may be* Dark, *when the* Rational Soul *is full of* Ideas, *and* vice verſâ. p. 126

Schol. Generale. *The Concluſion.*

CHAP. III.

Of the Uſe of the Arithmetick of Infinites.

§. THE Arithmetick of Infinites *apply'd to* Arithmetical *Progreſſions.* p. 131

Prop. I. *To find the* Sum *of all* Arithmetical *Progreſſions going on* in Infinitum. p. 132

Prop. II. *To find the Sum of Infinite* Arithmetical *Progreſſions, when the laſt term is any given* Infinite. p. 135

§. II. *The* Arithmetick *of* Infinites *apply'd to* Geometrical *Progreſſions.* ibid

Caſe. I. *This* Arithmetick, *apply'd to* deſcending Geometrical *Progreſſions whoſe laſt term is o.* p. 136

Prop. I. *In all* Deſcending *Progreſſions whoſe Number of terms is* Infinite, *the firſt term Finite, the* Sum *is a Finite Quantity.* Ibid

Prob. *Having the firſt Term, and the* Ratio *of the Terms, of any* deſcending Geometrical *Progreſſion, whoſe laſt Term is o, to find another, whoſe firſt Term ſhall be any given Number, and the* Sum *equal to the* Sum *of the given* Progreſſion. p. 137

Caſe. II. *The* Arithmetick of Infinites *apply'd to* Aſcending *Progreſſions.* p. 138

Prop. II. *To find the* Sum *of ſuch Progreſſions when the laſt Term is* Infinite, *and firſt Finite.* ibid

Prob. II. *Any* Aſcending *Geometrical Progreſſion given, to find* another, *whoſe* Sum *ſhall be equal to the* Sum *of the given One.* p. 140

§. III. *Some further Application of the* Arithmetick *of* Infinites *to* Arithmetical *Progreſſions.* ibid

Prob. I. *Having the* laſt *Term, and the common* Difference, *of any* Aſcending Arithmetical *Progreſſion, to find* another, *whoſe* Sum *ſhall be equal to the* Sum *of the Given.* p. 141

§. V.

The CONTENTS.

§. V. Lemma *The Application of the* Arithmetick of Infinites *to Series, ariſing from the Powers of* Binomial *Quantities.* p. 143

Caſe I. *The* Series *ariſing from the Powers of ſimple* Infinite. p. 144

Caſe II. Series *ariſing from the Powers of the next immediate Species of thoſe* Infinites. p. 145

Caſe III. Series *ariſing from the Powers of the kinds of Infinites next to thoſe.* p. 146

Schol. *To find the firſt Progreſſion of every ſuch Caſe.* p. 147

The reconciling a Difficulty *about the Sum of Natural Numbers from* Lemma *precedent, and* Prop. 1. §. 1. p. 181

§. VI. *The* Arithmetick of Infinites *apply'd to the Quadrature of* Curvilinear Spaces. p. 150

Prop. I. *The* Infinite Area *of an* Hyperbola *Given, to find another* Hyperbola, *whoſe infinite* Space, *ſhall be to the Given, in any Given* Ratio. p. 152

Prop. II. *To find an* Hyperbola *whoſe interminated* Space, *ſhall be equal to any Given Number.* p. 153

Prop. III. *To find the* Points, *where the* Curve *meets with its* Aſymptots *in any Given* Hyperbola. p. 155

§ VII. *Some Reflexions on* Indefinite *Quantities.* p. 161

§ VIII. *Containing ſome* Miſcellaneous *Things Relating to* Infinites.

Prop.

Prop. *A* Demonſtration *that* Unity *divided by* Relative Nothing, *is equal to Relative Infinite.* p. 165
The Conſideration of the ſeveral Powers of Infinite Arithmetical *Progreſſions.* p. 170
Prop. I. *To find the* Sum *of a* Series *of Numbers, whoſe Terms are the* Squares *of any* Arithmetical *Progreſſion.* p. 173
Prop. II. *To find the* Sum *of the* Cubes *of any* Arithmetical *Progreſſion.* ibid
Prop. III. *To find the* Sum *of the* Biquadrates *of any* Arithmetical *Progreſſion.* p. 175
Prop. IV. *The Univerſal* Exponent *of any Power whatſoever, of any* Arithmetical *Progreſſion being given, to find the* Sum, *in all poſſible Caſes.* ibid
Schol. *From thence to find the* Univerſal Quadrature *of all* Parabola's. p. 174
How from the Quadrature *of* Curves *expreſs'd by* one *Term, to riſe to the* Quadrature *of* Curves *expreſs'd by* more *Terms.* ibid

ADDITIONS.

Prop. I. *Concerning the Nature and Kinds of* Infinites *expreſs'd* by Series's. p. 176
Prop. I. *The firſt, ſecond, and laſt Term, with the Number of Terms, in two* Geometrical Series's *being Given, to compare their laſt Terms.* p. 178

The CONTENTS.

Prop. II. *Having the Second Terms, in Two* Geometrical Series, *whoſe firſt Term is in both Unity, together with the Number of Terms in the other, to find the other* Series *that ſhall make the laſt Term in both equal.* ibid.

Prop. III. *A General Method to find in any* Hyperbola *the Points where the Curve meets with its* Alymptots. p. 180, *and* 189

An Anſwer to Mr. Varignons *Reflections upon* Spaces Greater *than* Infinite. p. 183

Advertiſement.

THE Errors of the Preſs, in the *firſt Part*, not being ſuch as can ſtop the *Intelligent Reader*, I beg he will mend the following ones, of the firſt and ſecond Chapters of the *Second Part*, which were the moſt Material I could obſerve. *Page* 8. *Def.* 9. *Relative Nothing* is ſaid here to be generated by a perpetual *Subſtraction*, tho' the Signs be alternatly + and —. for theſe Reaſons, becauſe *Relative Infinite*, was ſaid to be generated by a perpetual *Addition*, and becauſe that after the firſt Term, every Two ſucceding ones in Relative *Nothing* 1 *is equivalent* to $-0\,1$ thus $1\overline{-1+}1-1+1-1$ &c. is $1\overline{-1+1}\overline{-1+1}\overline{-1+1}$ &c. $=1-01-01-01$ &c. and ſo in other Caſes. *p.* 22. *line* 10. for effect *read* affect : *p.* 27. *l.* 10. for $\infty^{n-1} : n :: 1 : 0$. *read* $\infty^{n-1}\ \infty^{n} :: 0 : 1$. *p.* 30. *l.* 7. for indefinite, *r.* Infinite. *p.* 32. The Errors of Calculation here, are corrected. *p.* 163. *p.* 41. *l.* 13. inſtead of Diſtance, *r.* Time employed in the Motion of Light. *p.* 42. *l.* 12. inſtead of waies, *r.* Times. *p.* 84. *l.* 23. inſtead of Relations, *r.* Revelations. *p.* 101. *l.* 17. inſtead of are eſſentially, *r.* are not eſſentially. *p.* 108. *l.* 21. inſtead of Limit, *r.* Light. The Errors of the *Third Chapter*, will not ſtop thoſe who wou'd otherwiſe underſtand it.

Part II.

PART II.

CHAP. I.

Of the Nature and Kinds of Infinites. *Of ſome of their reſpective Qualities, and of a New Arithmetick of* Infinites.

THAT we may reaſon as cautiouſly as poſſibly we can, about Matters ſo intricate, and ſo far remov'd from the common way of Thinking, as the Nature and Qualities of *Infinits*, and the other Subjects of this Chapter are; we ſhall begin with *Definitions* and *Axioms*, and proceed to ſome General *Propoſitions*, demonſtrated after the plaineſt manner, till we obtain *Principles* to found our conſequent Reaſonings on; and then draw ſuch Corollaries, from the ſeveral Parts, or from the whole, as ariſing neceſſarily from them, may be of uſe, to aſcertain ſome Speculations advanced in the foregoing *Treatiſe*; or may otherwiſe help, to conduct the Underſtanding in thoſe other *Sciences*, where they may find a place.

Definition I.

QUANTITY is what may be encreas'd or diminiſhed.

Tho' this *Definition* may not exhauſt the *Metaphyſical* Nature of *Quantity*; yet it points out that Quality in it, that is here chiefly regarded; for ev'ry quantity may be encreas'd or diminiſhed, and that continually, as ſhall be afterwards ſhown.

Definition II.

A BODY is an extended, impenetrable, paſſive, diviſible, unintelligent Subſtance.

This *Definition* alſo, tho' it exhauſt not, the internal eſſence and intimate Nature of Matter, yet it summs up, its ſenſible and moſt conſtant Qualities, by which it is diſtinguiſhed from every thing elſe.

Definition III.

The inherent *Principle* of *Activity*, in the great Bodies of the Univerſe, is *Gravitation* or ſomething *analogous* thereto.

Tho' I am perfectly convinced, from the Simplicity and Uniformity of the Divine Nature, and of all his Works, that there is ſome one great and univerſal *Principle*, running through the whole *Syſtem* of Creatures *analogically*, and congruous to their Relative Natures; which is the ſame in all Bodies great and ſmall, and the *Origin* of all their Natural Actions upon one another, with regard to their different Circumſtances; and that there is not a different *Principle* for the Natural Actions of the *Leſſer Bodies* from that which is the *Principle*, of the Natural Actions of the *Greater Bodies* of the *Univerſe*, but one and the ſame *Principle* in both, acting differently in different Circumſtances. Yet ſince *Gravitation*, or ſome thing *Analogous* thereto, ſeems neceſſary for accounting for the Conſtant and Regular Motions, and Actions upon one another, of the *Great Bodies* of the Univerſe. *Gravitation* or ſomething *Analogous* thereto muſt be a neceſſary Conſequence in the *Greater Bodies* of the Univerſe, of this more Univerſal Principle, and the *Origin* of the Activity of *Bodies*.

Definition IV.

A SPIRIT, is an extended, penetrable, active, indiviſible, intelligent Subſtance.

Body and *Spirit* are in ev'ry other Quality oppoſit, except in *Extenſion*, therefore as the foregoing *Definition* of Body, ſumms up its ſenſible and moſt conſtant qualities, ſo to aſſign the *Definition* of Spirit, there was nothing to be done, but to joyn the oppoſite Qualities of Body, to that of Extenſion or extended Subſtance.

Definition V.

The *Principle* of Action in Spiritual Subſiſtences, is, or ought to be, that Eſſential one of REUNION with the *Origin* of their Being, impreſs'd on ev'ry Individual of this Rank of Creatures.

The Univerſal *Principle* of *Action*, mentioned in the third Definition, that runs through all the *Syſtem* of Creatures, muſt *analogically* be carried through ev'ry Individual of *Spiritual* Beings, and can be nothing but this Eſſential Principle of REUNION with the *Origin* of their Being, as ſhall be afterwards demonſtrated at large.

Defi-

Definition VI.

A *finite Quantity* is that, of which the Bounds or Limits, beyond which it cannot reach, is *aſſignable.*

Thus a Line is finite, when both its Extremities are given, or the Points which are its Limits, beyond which it cannot reach, are *aſſignable:* An *Area* is finite, when it's terminating Lines are *aſſignable*; a *Solid* is finite, when its terminating Planes are *aſſignable*, a *Number* is finite, when the Unities (which are its Limits) of which it conſiſts, or the bounds beyond which it cannot reach, are *aſſignable.*

Definition VII.

An *Infinite Quantity* (in its ſimpleſt nature and loweſt degree) is that, ſome one or more of the Limits or Bounds of which, beyond which it cannot reach, are not *aſſignable.*

Thus a *right Line*, one or both of whoſe Extremities are not *aſſignable*, or the Points beyond which it cannot reach, are not *aſſignable*, is an *infinite right Line.* An *Area*, one or more of whoſe terminating Lines are not *aſſignable*, is an *Infinite Area*; a *Solid*, one or more of whoſe terminating Planes, are not *aſſignable*, is an *Infinite Solid.* A number, encreaſing continually, whoſe laſt encreaſe, is not aſſignable, or the Bounds beyond which it cannot reach, is not *aſſignable*, will at laſt make an Infinite Number.

Scholium.

An Infinite *Number*, may be ſuppos'd to be Generated, by the perpetual Addition of a finite Number to it ſelf. Thus $1 + 1 + 1 + 1 + 1$, *&c.* $a + a + a + a + a$ *&c.* become infinite. Or, it may be ſuppoſed to be Generated, by the perpetual Addition of finite Numbers, encreaſing in a regular Progreſſion, and in one conſtant Proportion one to another. Thus $1 + 2 + 4 + 8 + 16$, *&c.* (where the finite terms, perpetually encreaſe in the *ratio* of 1 to 2.) and $1 + a + a^2 + a^3 + a^4$ *&c.* (where the finite Terms, perpetually encreaſe in the *ratio* of 1 to a) become infinite. And it is the ſame in all other infinite *Series*, regularly Generated; or laſtly, the infinite Number, may be ſuppoſed to be generated by the perpetual addition of finite Numbers, in no certain proportion one to another, nor in any regular progreſſion, ſuch as $7 + 1 + 30 + 5 + 2 + 25$ *&c.* Of theſe laſt kinds of Infinites, we have here no conſideration, for being of no conſtant or regular Nature, but merely caſual and fortuitous, they can afford no *Medium* for reaſoning. The Principal Deſign of this Chapter, ſo far as it concerns theſe two kinds of Infinites, is to find out a *Method*, for reſolving the ſecond kind of Infinites into the firſt when it is poſſible; in order then to obtain a juſt Notion of theſe Infinites, let us firſt diſtinguiſh Infinite in general, into *Relative* or *Creaturely* Infinite, and *Supreme* or ABSOLUTE Infinite (of which the firſt is but a Created Image or Picture, as will be afterwards ſhown) let $\odot$ ſtand for finite in general, and ∞ ſtand for infinite in general as they reſpect Numbers; then $\odot 1$ and $\infty 1$ will be finite and infinite (as they reſpect Numbers) of the loweſt Degree and ſimpleſt Nature. Unity being the ſimpleſt number.

Definition VIII.

Relative Infinite (in its ſimpleſt Nature and loweſt Degree) is an infinite Quantity, as it ſtands related to a given Finite, by the perpetual Addition of which to it ſelf it is generated.

Thus $\infty 1$. is a *relative Infinite*, as it ſtands related to 1, a given finite, by the perpetual Addition of which to it ſelf, it is generated; that is, $\infty 1 = 1 + 1 + 1 + 1 + 1$ *&c.* And ∞a, is a *relative Infinite*,

as

as it ſtands related to the given finite *a*, by the perpetual Addition of which to it ſelf it is generated, or $\infty\ a = a + a + a + a + a$ *&c.*

Scholium.

In the ſame Relation, that relative Infinite ſtands above a given finite in *aſcending*, in the ſame may another quantity be ſuppoſed to ſtand below it, in *deſcending*, in which Caſe, we ſhall have a *relative infinitely great* Quantity, in *aſcending* above the given finite; and a *relative infinitely little* quantity, in *deſcending* below it. So that relative infinite in general, may be aptly diſtinguiſhed, in reſpect of the given finite, into *relative infinitely great*, and *relative infinitely little.* For brevities ſake, we ſhall call the firſt *relative Infinite*, the ſecond *relative Nothing.*

Definition IX.

Relative Nothing (in its ſimpleſt Nature and loweſt Degree) is an *infinitely little* quantity, as it ſtands related to a given finite, by the perpetual Subſtraction of which from it ſelf, it is generated. Let o ſtand for relative Nothing.

Thus $o1$, is a *relative infinitely little* quantity, as it ſtands related to Unity, by the perpetual Subtraction of which from it ſelf, it is generated; that is $o1 = 1 - 1 + 1 - 1 + 1 - 1 + 1 - 1$ &c. and $o\,a$, is an infinitely little quantity, as it ſtands related to the given finite a, by the perpetual Subtraction of which from it ſelf, it is generated; that is $o\,a = a - a + a - a + a - a$ &c.

Definition X.

An *Indefinite Quantity* (in its ſimpleſt Nature and loweſt Degree) is ſome mean proportional, between finite, and relative infinite or Relative Nothing.

For, as in *Deſcending* from 1 to 0, we do not immediately ſlip from finite to relative Nothing, but muſt neceſſarily paſs through the intermediate ſteps $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$ &c. in Arithmetical Progreſſions; and in *aſcending* from 1 to ∞ we muſt paſs through the ſteps between both 2, 3, 4, 5, &c. in the ſame kind of Progreſſions. So in the *Geometrical* Progreſſions, in *deſcending* from 1 to 0, we muſt paſs through theſe mean Proportionals ${}^{2}\!\sqrt{0}$ ${}^{3}\!\sqrt{0}$ ${}^{4}\!\sqrt{0}$ &c. and in the ſame Progreſſions, in *aſcending* from 1 to ∞, we muſt paſs through the mean Proportionals ${}^{2}\!\sqrt{\infty}$ ${}^{3}\!\sqrt{\infty}$ ${}^{4}\!\sqrt{\infty}$, &c. and theſe we call *Indefinites*. Thus in *Geometry*, if we cou'd imagine a *Circle*, drawn upon the ſumm of a finite right Line repreſenting 1, and an infinite right Line repreſenting $\infty 1$, as a *Diameter.* A Perpendicular erected on the Point where theſe Two Lines meet, reaching the *Circumference*, wou'd repreſent the *Indefinite* right Line implyed by $\sqrt[2]{\infty 1}$. Let $\propto$ ſtand for ſuch *Indefinite* Quantities in general.

Scholium.

Unity being the ſimpleſt *Finite* Number, by conſequence $\infty 1 = 1 + 1 + 1 + 1 + 1$ *&c.* muſt be the ſimpleſt *Infinitely great* Number. And $o1 = 1 - 1 + 1 - 1 + 1 - 1$ *&c.* muſt be the ſimpleſt *infinitely ſmall* Number. And by reaſon the greater the Number, denominating the Root is, the leſs the Root it ſelf will be, therefore $\sqrt[\infty]{\infty 1}$ ($=$ to any Finite Number greater than Unity) will be the ſimpleſt Indefinite. Put $\sqrt[\infty]{\infty 1} = y = \infty^{\frac{1}{\infty}}$ therefore $\frac{1}{\infty} L \infty = Ly.$ but $L \infty = \infty$ (as will be ſeen by the laſt Chapter) therefore $\frac{1}{\infty} \times \infty = Ly.$ that is $\frac{\infty}{\infty} = 1 = Ly.$ But 1 may be the *Logarithm* of any finite Number, greater than Unity, in the Scale of proportionals $1^0.\ a^1.\ a^2.\ a^3.\ a^4.$ *&c.* therefore $\sqrt[\infty]{\infty 1}$, may be any finite Number greater than Unity. The *Indefinits* of the firſt degree, that is wherein the Number denominating, the Root is an integer, may be univerſally thus expreſs'd

$$\sqrt[m]{a} = \frac{1}{\sqrt[m]{\infty}} = \overline{1-1}|^{-\frac{1}{m}} = 1 + \frac{1}{m} + \frac{1 \times \overline{m+1}}{m \times 2m}$$

+

$+\frac{1\times\overline{m+1}\times\overline{2m+1}}{m\times 2m\times 3m}+\frac{1\times\overline{m+1}\times\overline{2m+1}\times\overline{3m+1}}{m\times 2m\times 3m\times 4m}+$ &c. Now as $\infty\,1=1+1+1+1+1$ &c. and $0\,1=1-1+1-1+1-1$ &c. and $\sqrt[\infty]{\infty\,1}$. are of the ſimpleſt Nature, ſo alſo are they of the loweſt Degree. The ſuperior Degrees being generated of $\infty\,1$, after the ſame manner that $\infty\,1$ is of 1, for if we add $\infty\,1$, perpetually to it ſelf, we ſhall have a *relative infinitely great* quantity, of the ſimpleſt Nature in it's kind, but of a higher Degree. *viz.* $\infty\,1+\infty\,1+\infty\,1+\infty\,1$ &c. $=1+1+1+1+1+1+1$ &c. $+1+1+1+1+1+1$ &c. $+1+1+1+1+1$ &c. &c. = (Since a perpetual Addition of any quantity to it ſelf, is equal to a Multiplication by $\infty\,1$) $\infty\,1\times\overline{1+1+1+1+1+1 \text{ \&c.}}=\infty\,1\times\infty\,1=\infty^2$. So $\infty\,a+\infty\,a+\infty\,a+\infty\,a$ &c. $=\infty\times\overline{a+a+a+a+a+a \text{ \&c.}}=\infty\times\infty\,a=\infty^2a$. After the ſame manner $0\,1=1-1+1-1+1-1$ &c. If ſubſtracted perpetually from it ſelf, it becomes $0\,1-0\,1+0\,1-0\,1$ &c. $=\overline{1-1+1-1+1-1 \text{ \&c.}}-\overline{1-1+1-1+1-1 \text{ \&c.}}+\overline{1-1+1-1+1-1 \text{ \&c.}}-\overline{1-1+1-1+1-1 \text{ \&c.}}+$ &c. = (ſince a perpetual Subſtraction of a quantity from it ſelf is the ſame with a Diviſion by ∞) $\frac{1-1}{+1}$

$\frac{+1-1+1-1\,\&c.}{\infty}=\frac{0}{\infty}=\frac{1}{\infty}\times 0=0\times\overline{1-1+1-1+1-1\,\&c.}=0^2$. Thus we have a relative Nothing leſs than 0, but of a ſuperior degree, for as *relative infinitely great* Numbers, encreaſe in their value, by being raiſed to ſuperior degrees, ſo *relative infinitely little*, decreaſe, becauſe the firſt perpetually aſcend from Finite, the Latter *deſcend* perpetually further from it. And thus all the Degrees that Finite Quantities admit of, may be form'd, from relative Infinits and Nothings. And as we have Indefinites $\sqrt[m]{\infty}$ between 1 and Infinite in *aſcending*, and $\sqrt[m]{0}$ between 1 and 0, in deſcending, ſo *Analogous* to their Natures we have the ſuperior Degrees $\sqrt[m]{\infty}^{\,n}$ and $\sqrt[m]{0}^{\,n}$. Nature in all theſe caſes admitting of no Bounds nor Limits.

Definition IX.

Abſolute or SUPREME Infinite, in a proper Senſe, is one, Individual, admitting of neither encreaſe, nor diminution, or of any Operation that *Mathematical* Quantity is ſubjected to.

This will be better Underſtood afterwards.

Defi-

Definition. X.

Abſolute Nothing in a proper Senſe, is neither capable of encreaſing nor diminiſhing, nor of anywiſe altering any *Mathematical* Quantity to which it is apply'd, but ſtands in full oppoſition to *abſolute* Infinite.

Axioms.

I. That which is greater or leſs than any poſſible Finite Quantity how great or little ſoever, mnſt be a *relative Infinite, Indefinite*, or *Nothing*, and which of all theſe Three, the given Quantity is, the ſtate of the Caſe will always determin.

Beſides, *Infinite, Indefinite*, and *Nothing*, relatively conſidered, we have no *Idea's* of Quantity, and the Definitions of theſe already given, apply'd to the ſtate of the Caſe under conſideration, will always determine which of theſe, the Quantity aſſigned muſt be.

II. Number being the ſimpleſt Meaſure of Quantity, and a proper Unity being the Meaſure of all Number, a proper Unity is the Meaſure of all Quantity.

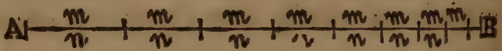
That Unity, is the Meaſure of all Integers is evident: And in Fractions, the *Denominator* determines the proper Unity, whereof the *Numerator* determines the Number. Wherefore in the following Propoſitions inſtead of Quantity, we ſhall frequently uſe it's Meaſure Number, to expreſs their meaning and to demonſtrate their Truth.

Propoſitions.

I. *Quantity* may be encreas'd or diminiſh'd in *Infinitum.*

Caſe 1. That *Quantity* may be encreas'd in *Infinitum*, is evident from hence, that ſince it is certain, a Finite Quantity may be added to a Finite, what may be once done, may be done again and again, and conſequently may be done any Number of Times, greater than any Finite Number how great ſoever, that is by *Definition* 4. and *Axiom* 1. Quantity may be encreas'd in *Infinitum.*

Caſe 2. That *Quantity* may be diminiſhed in *Infinitum* is evident from hence that out of the given Quantity *AB*, by the *Sixth Book of Euclid*, you may take out any given $\frac{m}{n}$ Part, and out of the Remainder, you may alſo take out any $\frac{m}{n}$ Part, for the ſame Reaſon that you can take it out of the firſt given Quantity *AB*, and ſo on continually, and yet

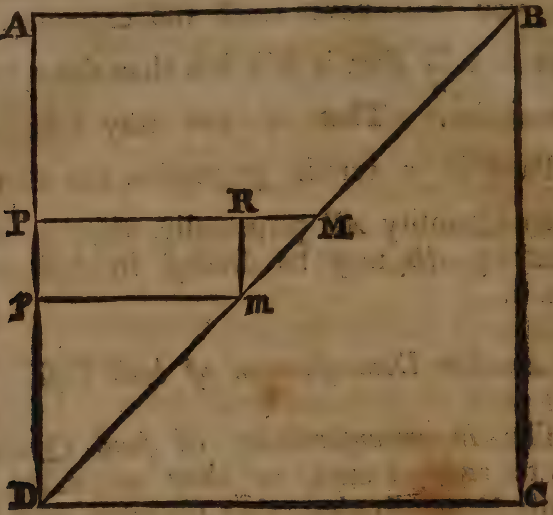


yet you ſhall never reach the extremity *B*, ſince the $\frac{m}{n}$ Part is ſtill leſs than the whole Remainder. That is, you may take out $\frac{m}{n}$ Parts in a certain proportion out of the given Quantity *AB* perpetually, that is, the Quantity *AB* may be divided in *Infinitum*. q. e. d.

Another Demonſtration of both Caſes.

The *Incommenſurability* of *ſurd* Quantities to *rational* ones, as they are call'd, is a full Demonſtration, that *Quantity* may be encreas'd or diminiſh'd in *Infinitum*.

Let



Let *ABCD* be a ſquare, whoſe *Diagonal* is *DB*, putting the ſide *AD* = 1. Then is *AD*, to *DB*, as 1 to $\sqrt{1}$. Take in the ſide *AD*, apart *Pp* the leaſt poſſible draw *PM. p m.* parallel to *AB* and *Rm* parallel to *AD*. Since the Triangles *BAD* and *MRm* are ſimilar, *Rm* will ſtill be to *mM* as 1 to $\sqrt{1}$. therefore it is impoſſible to find in *AD*, a Part how ſmall ſoever, that taken, any Finite Number of Times, how great ſoever, ſhou'd be equal to *mM*. So that let *AD* be divided into parts how ſmall ſoever, and how many ſoever, yet ſtill *DB* may be further divided. That is *per Def.* 5. and 4. and *Axiom* 1. *DB* may be divided in *Infinitum*, and *AD* encreas'd in *Infinitum*. q. e. d.

Corol-

Corollary I.

Hence it is evident, that to aſſign the *abſolutely* greateſt *relative Infinite*, or the *abſolutely* leaſt *relative Nothing* is a plain Contradiction, ſeeing both theſe are ſtill *Mathematical* Quantities (as is plain from *Def.* 1. 4. & 5 and ſhall be afterwards further demonſtrated) and ſo by this Propoſition, are capable of further encreaſe or diminution; and ſo the aſſign'd can neither be the *greateſt* nor *leaſt*, *abſolutely*.

Corollary II.

Hence, and from *Def.* 4. & 5, we may diſcover wherein the *ſpecifick* difference between *Finites* and *relative Infinites* or *Nothings* conſiſts: To wit, in the limited encreaſe or diminution of the former, and in the perpetuity of the encreaſe or diminution of the latter, for aſſoon as the encreaſe or diminution in theſe latter ſtops, they become limited and aſſignable, and conſequently Finite, and thereby, no part of the deſired Infinite.

Corollary III.

Hence it appears, that an Infinite of either ſort is (as to all *Arithmetical* Operations on it, with due regard to the perpetuity of its encreaſe, or diminution,) of the Nature of an *unknown* quantity in *Algebra.* For as in this, from the ſtate of the *Problem*, we perform *Arithmetical* Operations on it, as it were known, and thereby we ſometimes do, and ſometimes do not determine its value, but by Approximation: So on this, we may perform the like Operations as upon an unknown quantity, with due regard to its particular nature, and the State of the *Problem*, and thereby often diſcover the *ſpecifick Genius* of its Progreſſion, which is always *Regular* and *Harmonious*, as will be afterwards ſeen.

Propoſition II.

Unity divided by an *infinite number* of *Unities* makes the Quotient *relative Nothing* or $\frac{1}{\infty}$ $= 0$.

Demonſtrat. $\infty 1 = 1 + 1 + 1 + 1 + 1$ *&c.* *per Def.* 4. *&* $01 = 1 - 1 + 1 - 1$ *&c. per Def.* 5. divide 1, by $1 + 1 + 1 + 1 + 1$ *&c.* and by the common Operations of *Algebra*, you ſhall have $1 + 1 + 1 + 1 + 1$ *&c.*) 1 ($1 - 1 + 1 - 1 + 1$ *&c.* $= 0$. q. e. d.

Corollary I.

From hence it is evident, that *Unity* divided by *relative Nothing* is equal to $\infty\,1$. for $1-1+1-1+1-1$ &c. $=0)\,1\,(1+1+1+1+1$ &c. $=\infty\,1$ therefore $\frac{1}{0}=\infty$.

Corollary II.

Hence alſo it follows, that $\infty\times 0=1$. But this may be demonſtrated otherwiſe thus. $\infty\,1=1+1+1+1+1$ &c. *per Def.* 4. Multiply both by *o* and then it is, $\infty\,0=01+01+01+01$ &c. $=0\times\overline{1+1+1+1+1\text{ &c.}}$ but by *Prop.* 2. $0=\frac{1}{\infty}$. and $1+1+1+1$ &c. $=\infty$. therefore $\infty\times 0=\frac{1}{\infty}\times\infty=\frac{\infty}{\infty}=1$ q. e. d.

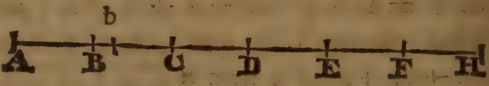
Propoſition III.

As *Finite* in General is to *relative Infinite* in General, ſo is *relative Nothing*, to *Unity*. That is $\Theta:\infty\Theta::0:1$.

Demonſtrat. By 1. *Corollary Prop.* 2. $\frac{1}{0}=\infty$. Multiply both by Θ then $\frac{\Theta\,1}{0}=\infty\Theta$ that is $\Theta\,1=\infty\Theta\,0$. therefore $\Theta:\infty\Theta::0:1$. q. e. d.

Propoſition IV.

Relative Nothing is a real *Mathematical* Quantity, and implies the leaſt part of the Finite, to which it is related or compared.



Demonſtrat. This is evident from the Generation of *Relative Nothing*, aſſign'd in *Def.* 5. But to demonſtrate the Propoſition, without regard to this Definition, let *AH* infinitely produced from *A*, be divided into equal Parts *AB*, *BC*, *CD*, *DE*, *&c.* So that an equal part of this Line may denote any Number. Suppoſing $AB = 1$, let x denote any Number, for Example $x = AB$, $y = Ab$ then by the common Rules of Diviſion $\frac{1}{y-x} = \frac{1}{y} + \frac{x}{y^2} + \frac{x^2}{y^3} + \frac{x^3}{y^4}$ *&c.* Now ſuppoſe b infinitely near to B, then $y - x = Bb = \dot{x}$ & $\frac{1}{\dot{x}} = \frac{1}{y-x}$ but $x = \dot{x} + \dot{x} + \dot{x} + \dot{x}$ *&c.* by *Def.* 4. that is $x = \dot{x} \times \overline{1 + 1 + 1 + 1 \text{ \&c.}}$ therefore $\frac{1}{\dot{x}} = \frac{1}{x} + \frac{1}{x} + \frac{1}{x} + \frac{1}{x}$ *&c.* But by Suppoſition $AB = x = 1$ therefore $\frac{1}{\dot{x}} = 1 + 1 + 1 + 1 + 1$ *&c.* $= \infty 1$. But by *Corollary* 1. *Prop.* 2. $\frac{1}{0} = \infty$ therefore $\frac{1}{\dot{x}} = \frac{1}{0}$ and

$\frac{1}{o}$ and conſequently $\dot{x}=o$. But $\dot{x}$ being a real *Mathematical* Quantity, by *Def.* 1. o. alſo muſt be a real *Mathematical* Quantity, and the leaſt part of Unity to which it ſtands related or compared. q. e. d.

Corollary I.

Since ∞ aſcends from the given Finite, in the ſame manner that o deſcends below it, and ſince o is a real *Mathematical* Quantity, ſo alſo muſt ∞ be. And as o is the leaſt relatively below it in it's own order, ſo is ∞ the greateſt relatively above it in it's order, but both below and above theſe, we may *deſcend* or *aſcend* in a higher order or degree, without Bounds or Limits.

Corollary II.

When a *Curve* is ſaid to meet with it's *Aſymptot*, and when in the common *Hyperbola*, we obtain the *Area* $\frac{1}{1-1}$ or in the Example propoſed we put $y=x$, in theſe and ſuch like Caſes we mean only, that in the firſt caſe the *Ordinate* is infinitely little, in the Second, we mean the leaſt part of the *Abſciſs*, and in the Third that y and x muſt differ only, by an *infinitely little* part of x, or by $\dot{x}$ only; and not that they are *abſolutely* equal; elſe there would be no Diviſion, and conſequently no Quotient, as ſhall be afterwards ſhewn.

Corollary III.

Since by *Corollary* 1, 2d *Prop.* $\infty = \frac{1}{0} = \frac{1}{1-1+1-1+1}$ *&c.* $= 1+1+1+1+1$ *&c.* Since alſo $\frac{1}{1-1} = 1+1+1+1+1$ *&c.* as is evident from the common Rules of Diviſion, ſeeing the Two firſt Terms only effect the Quotient; (all the reſt being but repetitions of the ſame Terms,) and laſtly, ſeeing the ſame Quotient is obtain'd whether the Diviſor be $1-1$ or $1-1+1-1+1-1$ *&c.* the reiterated Multiplication of the Quotient upon the Diviſor, producing the ſame effect (in the actual Operation of the Diviſion) which ſoever of the Diviſors we chooſe, we may ſafely put in common Caſes $1-1$ or $2-2$ or $a-a$ for *o*.

Corollary IV.

From hence, and *Def.* 4. we may diſcover the true meaning of the Expreſſion, when it is ſaid a *Quantity* is greater than *Infinite*, or one *Infinite* is greater than another. In theſe and the like Expreſſions $\infty 1 = 1 + 1 + 1 + 1 + 1$ *&c.* is always ſuppoſed the common Standard or Meaſure, to which all others are compared. Proper *Unity* being by *Axiom* 2. the common Meaſure of all Quantity, and when a Quantity x is ſaid to be greater than *Infinite*, the meaning is, that it may be an Infinite, greater than $\infty 1$. and when $\infty 2$ is ſaid to be greater than $\infty 1$, it is no more than to ſay $2 < 1$. In all theſe *relative Infinites* admitting of compariſon, there is ſtill a particular Finit, to which each reſpectively are related, and it is on theſe Finites that the comparing the *Infinites* among themſelves is founded. Thus $\infty 2 = \frac{2}{0} = \frac{2}{1-1} = 2 + 2 + 2 + 2$ *&c.* when compared with $\infty 1 = \frac{1}{0} = \frac{1}{1-1} = 1 + 1 + 1 + 1$ *&c.* the finite Parts of theſe Two Infinites, *viz.* 2, and 1, are the Subjects of the Compariſon. And when $\infty 2$ is ſaid to be greater than $\infty 1$, it means only that the Finite's Parts, of which they are Generated, are as 2 to 1, or theſe in the firſt are double of thoſe in the ſecond. It is the ſame thing as in $\Theta 2$, compared with $\Theta 1$, or $2x$ with $1x$, nothing is meant in either, but that 2 is greater than $1 : \Theta$, and x, and ∞, being as to this Caſe, equally unknown Quantities, which may be thrown out in the Compariſon, and *univerſally*, in all relative Infinites $\infty\, n, = n+n+n+n$ *&c.* and in all relative Nothings $o\, n, = n - n + n - n + n - n$ *&c.* $\infty\, n = \frac{n}{o}$ is the expreſſion of the *Ratio* of the firſt Series, and $o\, n = \frac{n}{\infty}$ is the expreſſion of the *Ratio* of the ſecond Series, and theſe Two $\frac{n}{o}$ and $\frac{n}{\infty}$ are proper Subjects of the compariſon, where n may admit of all the Relations that Finites have among themſelves.

Propoſition V.

Relative Infinites, *Indefinites*, and *Nothings* (with the proper Limitations peculiar to each) admit of all the Degrees and *Arithmetical* Operations, that Finite or *Mathematical* Quantities are ſubjected to.

Demonſtrat. This is evident from *Def.* 4, 5, and 6. and the *Scholia* adjoyning to theſe, and is alſo manifeſt from the precedent *Prop.* and it's firſt *Corollary*, as to relative Infinites, and Nothings; and ſhall be afterwards ſhown, as to Indefinites, to wit, that all theſe are ſtill *Mathematical* Quantities, capable of Encreaſe and Diminution *in Infinitum*, and conſequently muſt admit of all theſe *Arithmetical* Operations (with proper Limitations peculiar to each) that finite Quantities are ſubjected to. And to confirm this, we may obſerve in *Nature*, a reſemblance of theſe higher Degrees of *relative Infinites*, and conſequently by *Analogy*, of *relative Nothings* alſo. For if *Space* be *Infinite*, as ſhall be afterwards Demonſtrated, it muſt be ſuppoſed equal to an infinite *Cube* or *Sphere*, whoſe *Diameter* will be as $\infty\ 1$, it's Section through this *Diameter* as ∞^2, and it's *Content* as ∞^3. q. e. d.

Propoſition VI.

Relative Infinite has, to the Finite with which it is compared, no finite Proportion, or Finite when compared with it's proper relative Infinite becomes relative Nothing.

Demonſtrat. This is evident from 4 *Corollary Prop.* 4. the *Ratio* of the relative Infinites in general $\infty n = n + n + n + n$ *&c.* being $\frac{n}{0}$ that is $\infty n = \frac{n}{0}$ therefore $\infty n : n :: 1 . 0.$ q. e. d. on the other ſide let us ſuppoſe the *Ratio* of the relative Infinite in general ∞n to n, to be a finite Ratio $\frac{s}{r}$ then $\infty n = \frac{r}{r}$ which is impoſſible by 2 *Co-*

rollary *Prop.* 3. wherefore ſince $\infty n : n :: 1 : o$ by compoſition of Ratio's, $\infty n + n : n :: 1 + o : o$ but $1 + o$ is but 1. therefore $\infty n + n$ is but ∞n, or n a finite Quantity when compared with it's relative Infinite ∞n becomes o. q. e. d.

Corollary I.

Hence, *relative Infinite* in General, is to *Finite* in General, as *Unity* is to *relative Nothing*: or any *Finite*, when compared with *relative Infinite* in General, becomes *relative Nothing*: that is $\infty : \Theta :: 1 . o$.

Demonſtrat. By the *precedent Propoſition* $\infty n : n :: 1 : o :: a : o a$, and by converſion of ratio's $\infty n : a :: n : o a$. Suppoſing then a to be a *Finite* quantity, nothing but an Infinite number of relative Nothing or o's being equal to 1, by *Corollary* 2. *Propoſition* 2. $o a$ muſt be ſtill o, or $a - a + a - a + a - a$ &c. $= o$, by *Corollary* 3. *Propoſition* 4. wherefore $\infty n : a :: n : o$, and by Compoſition of *ratio's* $\infty n + a : a :: n + o : o$, put $n = 1$ and $a = \Theta$ then $\infty + \Theta : \Theta :: 1 + o : o$: and ſince $1 + o$ is but 1, therefore $\infty + \Theta$ is but ∞; wherefore $\infty : \Theta :: 1 : o$, or when any Finite is compared (by Addition, (or by Subtraction by Diviſion of ratio's)) with *relative* Infinite in General, it becomes *relative Nothing* q. e. d. The true *Analogy* is this,

∞n or $n + n + n +$ &c. $a : : n : a - a + a - a + a - a$ &c. but becauſe a is ſuppoſed Finite, $a\ o$ is the ſame (in Caſes of Addition and Subtraction) with o. But were $a = \infty\ 1$, then $a - a + a - a + a - a$ &c. wou'd be $\infty - \infty + \infty - \infty + \infty - \infty$ &c. $= \infty \times \overline{1 - 1 + 1 - 1 + 1 - 1 \text{ \&c.}} = \infty \times o = 1$, and $\overline{\infty n - \infty n + \infty n - \infty n \text{ \&c.}} = \frac{\infty}{\infty} n = n$.

Corollary II.

Put n equal to any Integer, then $\infty^{n-1} : n : : 1 : o$, but $o^{n} : o^{n-1} : : o : 1$, for the firſt being reduced, becomes $\infty : 1 : : 1 : o$, and the ſecond being reduced, becomes $o : 1 : : o : 1$; and therefore when ∞^{n-1} is to be added to, or ſubtracted from ∞^{n}, it becomes o; and when o^{n} is to be added to, or ſubtracted from o^{n-1} it becomes alſo o, by *Scholium Def.* 6. and the Caſe is the ſame when the Inferior Powers ſuppoſe ∞^{n-2}, or ∞^{n-3} &c. are to be added to, or ſubtracted from ∞^{n}, or when o^{n} is to be added to, or ſubtracted from the Inferior Powers o^{n-2} or o^{n-3} &c. in all ſuch caſes its evident from the precedent *Prop.* and its 1. *Corollary*, that ∞^{n-2} ∞^{n-3} and o^{n} become o.

Scholium.

From theſe *Propoſitions* and *Corollaries*, an *Arithmetick* of Infinites may be drawn out, different from any hitherto publiſhed, of no contemptible uſe, or narrow extent in *Algebra*, and *Geometry*; as will be in ſome meaſure ſhown by the Third Chapter.

The Arithmetick of Infinites.

ADdition. $2\infty + 3\infty = 5\infty$. $a\infty + 2a\infty = 3a\infty$. $\infty^2 + 2\infty^2 = 3\infty^2$. $\infty^n + p\infty^n = \overline{1+p}\,\infty^n$. $a\infty + e\infty = \overline{a+e}\,\infty$. $3\infty + 10 = 3\infty$. $a\infty + a = a\infty$. $\infty^2 + \infty = \infty^2$. $\infty^n + \infty^{n-1} = \infty^n$. *Let q be leſs than n, by a finite Integer, then* $\infty^n + \infty^{n-q} = \infty^n$.

Subſtraction. $5\infty - 2\infty = 3\infty$. $10a\infty - 3a\infty = 7a\infty$. $6n\infty - 4n\infty = 2n\infty$. $5\infty - 7\infty = -2\infty$. $7\infty^3 - 5\infty^3 = 2\infty^3$. $9\infty^p - 5\infty^p = 4\infty^p$. $5\infty^p - a\infty^p = \overline{5-a}\,\infty^p$. $3\infty - 7 = 3\infty$. $a\infty - a = a\infty$. $\infty^p - \infty^{p-1} = \infty^p$. *Let q be an Integer, leſs than p, then* $\infty^p - \infty^{p-q} = \infty^p$.

Multiplication. $\infty \times 3 = 3\infty$. $\infty \times a = a\infty$. $\infty \times \infty = \infty^2$: $\infty^2 \times \infty^3 = \infty^5$. $\infty^p \times \infty^q = \infty^{p+q}$. $a\infty \times e\infty = ae\infty^2$. 3∞

$a \times 4 \infty x = 12 \infty^2 a x. \quad -2 \infty \times -3 \infty = 6 \infty^2. \quad -\infty a \times + \infty = -\infty^2 a.$

Diviſion. $\frac{\infty}{2} = \frac{1}{2} \infty.$ or $\infty \frac{1}{2}.$ $\frac{\infty a}{e} = \infty \frac{a}{e}.$ $\frac{2 \infty}{\infty} = 2.$ $\frac{3 \infty}{4 \infty} = \frac{3}{4}.$ $\frac{\infty a}{\infty e} = \frac{a}{e}.$ $\frac{\infty 2}{\infty} = \infty.$ $\frac{\infty 3}{\infty} = \infty^2.$ $\frac{\infty^p}{\infty^q} = \infty^{p-q}.$ $\frac{+3 \infty}{-\infty} = -3.$ $\frac{-4 \infty}{-2 \infty} = +2.$ $\frac{-\infty a}{+\infty e} = -\frac{a}{e}.$

Fractions. $\infty \frac{2}{3} + \infty \frac{4}{5} = \infty \frac{22}{15}.$ $\infty \frac{a}{e} + \infty \frac{p}{q} = \infty \frac{aq+ep}{eq}.$ $-\infty \frac{3}{2} + \infty \frac{4}{5} = \frac{2}{15} \infty.$ $\infty \frac{a}{e} - \infty \frac{p}{q} = \infty \frac{aq-ep}{ep}.$ $\infty \frac{a}{e} \times \infty \frac{p}{q}. = \infty^2 \frac{ap}{eq}.$ $\infty \frac{a}{e}) \infty \frac{p}{q} (= \frac{ep}{qa}.$ $\infty \frac{5}{4}) \infty \frac{2}{3} (= \frac{8}{15}.$

Thoſe who are ever ſo little acquainted with the *Specious Arithmetick*, will eaſily underſtand the reaſon and Truth of theſe Operations.

Propoſition VII.

Indefinite Quantities are not properly either Finite or Infinite, but between both.

Demonſtrat. An Indefinite Quantity is ſome mean Proportional, between Finite and relative Infinite, *per Def.* 6. that is, one of thoſe Infinites will be $\alpha = \sqrt{\infty}\,\Theta$ put $\Theta = 1$, and then $\sqrt{\infty}$, will be an Indefinite Number, now this $\sqrt{\infty}$ can neither be Finite (and this manner of reaſoning will hold good of any other Indefinite whatſoever) nor Indefinite, not Finite, elſe Θ^2 would be Infinite, which is impoſſible; nor Infinite, for the leaſt poſſible Infinite, muſt be Infinite in general, divided by the greateſt poſſible Finite x, and then if $\sqrt{\infty}$ be Infinite, $\sqrt{\infty} = \frac{\infty}{x}$ and $x^2 = \frac{\infty^2}{\infty} = \infty$. which is alſo abſurd. Again if $\sqrt{\infty}$ be Infinite, then is $\infty \times \frac{1}{\sqrt{\infty}} (= \sqrt{\infty}) =$ Infinite, and $\frac{1}{\sqrt{\infty}}$ = to it's relative Infinitely ſmall part, or it's relative Nothing $= 0$, and ſo $\infty \times 0 = \infty \times \frac{1}{\sqrt{\infty}} = (\sqrt{\infty} =)$ to Infinite. But by *Corollary* 2. *Prop.* 2. $\infty \times 0 = 1$, and inſtead of $\infty \times 0$, putting it's value 1. in this laſt equation, it will be $\infty \times 0 = 1 = \infty \times \frac{1}{\sqrt{\infty}} =$ *Infinite*, by ſuppoſition; and this ſuppoſed Infinite would become 1, which is abſurd. q. e. d.

Scho-

Scholium.

Taking the inſtance of the Indefinite quantity propoſed $\sqrt{\infty}.\,1 = \sqrt{1+1+1+1}$ &c. It's plain the root of any given number grows Greater or Leſs, as the number expreſſing or denominating the root is Leſs or Greater; and in $\sqrt{\infty}\,1$, it's infinitely little root or ${}^{\infty}\!\sqrt{\infty}\,1$ may be any finite Number greater than Unity as has been already ſhown; and its infinitely great root or ${}^{1}\!\sqrt{\infty}\,1$ is Infinite. And between theſe Ly all the Indefinites that can be formed on 1 and ∞; to wit, ${}^{2}\!\sqrt{\infty}$, ${}^{3}\!\sqrt{\infty}$, ${}^{4}\!\sqrt{\infty}$, &c. and none of theſe can be properly called either, Finite or Infinite, but are in a perpetual Gradation towards either of theſe extremes, as the number that denominates the root grows greater or leſs; and they never become actually Finite, but when the number denominating the root is actually Infinite, nor actually Infinite, but when the Number denominating is *Unity*. And between theſe Two *Limits*, they are neither actually Finite not Infinite. Next to ${}^{1}\!\sqrt{\infty} = \infty$ (in order of the ſimpleſt Indefinites,) is ${}^{2}\!\sqrt{\infty} = 1 + \frac{1}{2} + \frac{3}{\infty} + \frac{5}{16} + \frac{35}{128}$ &c. wherein (by the quick encreaſe and greatneſs of the ſucceeding terms) the laſt becomes $\frac{1}{\infty}$ in a few Number, ſo to ſpeak, of theſe terms, where the ſeries terminates, and ſo their ſum $^{2}\sqrt{\infty}$. becomes thereby leſs than ∞ 1. as will be more fully explain'd in the following Chapter, and in $^{5}\sqrt{\infty}$ (for example) $= 1 + \frac{1}{5} + \frac{6}{50} + \frac{66}{750}$ *&c.* we ſee the terms of the Series converge yet faſter, and will thereby terminate at $\frac{1}{\infty}$, much ſooner. And ſo their ſum $^{5}\sqrt{\infty}$ will be much leſs than $^{2}\sqrt{\infty}$. And for theſe (even when they riſe to fractional Exponents whoſe Numerators are greater than 1, Such as $\infty^{\frac{2}{3}}$. $\infty^{\frac{3}{4}}$. $\infty^{\frac{4}{5}}$. *&c.*) an *Arithmetick* may formed, according to the example laid down in the *Scholium* of the precedent Propoſition, with this addition, that an Indefinite as $\infty^{\frac{q}{p}}$ or $^{p}\sqrt{\infty^{q}}$ multiplyed by another Indefinite $\infty^{\frac{r}{s}}$ gives the Product $\infty^{\frac{q}{r} + \frac{r}{s}}$ which becomes Infinite, when $q s + p r$ is $\doteq$ or $< p s$ and Indefinit when $q s - p r$ is $=$ or $> p s$.

And if an Indefinite as $\infty^{\frac{q}{r}}$ be divided by an Indefinite, as $\infty^{\frac{r}{s}}$ the Quotient $\infty^{\frac{q}{p} - \frac{r}{s}}$ is Infinite, when $q s - p r$ is $\doteq$ or $<$ $p s$ but is Finite when $q s - p r = 0$ and only Indefinite, when $q s - p r > p s$. as it ought to be according to the Arithmetick of Surds.

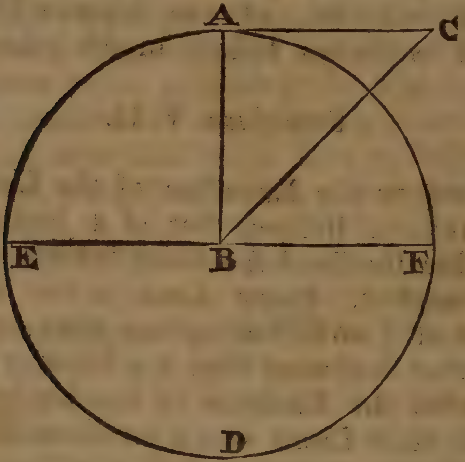
N. B. That in expreſſing an Indefinite by $\infty \frac{q}{p}$ it is always ſuppoſed that the Number q is leſs than p, for if q be either greater or equal to p ×, then $\infty \frac{q}{p}$ tho' it may be an Indefinite, of the ſuperior Degrees, yet it is always Infinite in it's value.

Propoſition VIII.

Space, or the Extenſion of the Univerſe, is a relative Infinite, but of a higher Degree than the ſimpleſt relative Infinite $\infty 1$.

Demonſtrat. Every *Limit* is the Termination of Two Diſtances, one going forward, the other backward from the limiting Point, and were the Extenſion of the Univerſe limited, theſe *Limits* wou'd terminate a Space, beyond theſe *Limits*, as well as within them. That is, either the univerſal *Space* muſt be unlimited, and conſequently Infinite, or there muſt be *Space* beyond the Limits of univerſal *Space*, which is abſurd. Again, if the Extenſion of the Univerſe were limited any way, ſo as to become Finite, then a *Sphere* of a finite *Diameter*, might be found equal to it. For a *Cube* of a Finite ſide, may be found equal to any Finite *Content* whatſoever,

ſoever, as is well known, and the *Radius* of a *Sphere* equal to this *Cube*, is the *Product* of the *ſide* of the *Cube*, multiplyed into the *Cube Root of* $\frac{3}{2}$ *parts of the* Ratio, *of the* Radius *to the Circumference.* Let us ſuppoſe the whole finite Extenſion of the Univerſe equal to the *Sphere* whoſe Radius



is *AP.* Let this *Sphere* be cut by a *Plane* through it's *Center*, and the *Section* be the *Circle ADFE*, it is certain from the *Elements of Euclid*, that to any given Point *A*, a *Tangent AC* may be drawn, of which only the Point *A* falls upon the *Circle*; the reſt of the Line *AC* falling without it. From whence it is evident, that there muſt be extenſion without this Circle, or the *Sphere*

Sphere by the Section of which it is Generated. Since a *Plane* paſſing through this *Tangent*, and perpendicular to the *Plane* of this *Circle*, will only touch the *Sphere* in a Point; by which there will be an extended diſtance remaining between the *Circumference* of the *Sphere*, and the *touching* Plane, in all their Points excepting that one at *A*; And ſince this is true of every *aſſignable* Extenſion how great ſoever, leſs than Infinite: It is evident the Extenſion of the Univerſe is greater than any *aſſignable* Extenſion, how great ſoever, that is, by *Axiom* 1. it is *relatively Infinite*, which is ſtill more evident from *Def.* 4. Since it's parts are Finite and their Sum only Infinite; and ſeeing this Infinite is of Three Dimenſions, or as $\infty 1$ in Height, Breadth, and Depth, therefore it muſt in it's Content be as ∞^3, that is, of a ſuperior Degree to $\infty 1$. q. e. d.

CHAP. II.

Of the PHILOSOPHICAL *Principles of Reveal'd Religion.*

Lemma I.

THERE is in all the Works of Nature, a *Symmetry*, and *Harmony*, running on in a perpetual *Analogy* (with proper Limitations ariſing from the different Circumſtances of the ſeveral Parts) through the whole and the parts, or there is a *regular Connexion*, and *uniform Proportion* between ſimilar Cauſes and Effects, a Congruity between the End and the Means. An Aptitude between the Faculty and it's Acts, and between the Organs and their intended uſes, in the whole, and in the ſeveral parts of this *Syſtem* of things.

Demonſtrat. This is evident from innumerable Inſtances already diſcover'd and aſcertain'd. And every new Diſcovery in the moſt minute part of the Works of Nature, carries along with it a freſh *Demonſtration* of this Propoſition; one muſt be intirely ignorant of *Philoſophy*, and *Mathematicks*, to want a Cloud of Witneſſes to this Truth.

For Inſtance, the *ſeſquialter Proportion*, of the Periodical times of the Revolutions of the *Primary Planets*, about the *Sun*; and of the *Secundary Planets*, about the *Primary ones*; to their *middle Diſtances*, from the *Sun* and *Primary Planets* reſpectively, obtains univerſally. Their *Magnitudes*, *Gravities*, *Denſities*, and their *Velocities* in their *Orbits*, in reſpect to, and about the *Sun*, and the *Primary Planets*, in the *Planets*, *Comets*, and *Satellits*, are in a regular and comely Proportion; the ſame *Gravity*, the ſame Law thereof, and the ſimilar effects of both, obtains through the whole material *Syſtem* of things. The *Reflexions*, *Inflexions*, and *Refractions* of Light, are the ſame, in all the *Planetary* and *Cometary* Bodies and Regions; as they are on our Terreſtrial Globe, with due regard to the different *Denſities* of the *Mediums*. The *Circulation* of the *Fluids*, the *Manner*, and *Organs* of *Reſpiration*, and *Generation*, are *Analogically* the ſame in *Man*, *Brutes*, and *Vegetables*; with proper Limitations ariſing from the differing Circumſtances of theſe Gradations of *Animals*. The *general Laws of Fluids*, *Elaſticity* and *Gravity*, obtain in *Animal* and *inanimate Tubes*, but ſo far as they are alter'd in the firſt, by *Collateral* Cauſes. The whole of *Philoſophy* and *Mathematicks*, is nothing but particular Inſtances of this Beautiful

Analogy, and the preceeding Chapters of the *firſt Part*, contain nothing but particular Inſtances thereof. And if we deſcend into the *Spiritual World*, we ſhall find this Beautiful *Analogy* preſerv'd, as far as the different Circumſtances of theſe Beings will permit. And if in this Demonſtration, it were allow'd to take in the Suppoſition of a *Being infinitely perfect*, who contrived and executed the whole, and the ſeveral Parts of this *Syſtem* of Things; it is impoſſible it ſhou'd be otherwiſe: A Being infinitely Wiſe, Simple, and One, muſt neceſſarily bring about Similar Ends by Similar Means, and perform all his Works the plaineſt, moſt Simple, and ſhorteſt way poſſible, due regard being had to the whole and the different Circumſtances of the ſeveral Parts. *Wiſdom in Things*, is their *Symmetry*, *Regularity*, and *Aptitude* for obtaining their deſign'd Ends and Purpoſes. The *Wiſdom* of a *Machin*, conſiſts in the due proportioning of the ſeveral Parts to one another, and to the whole, for obtaining it's propoſed End. *Diſproportion*, *Irregularity*, *Diſcord*, and the having no View or Deſign, are the ſureſt Proofs, and Indications, of Chance, Impotence, and Folly: A Wiſe Man performs all his Works, in Number, Weight, and Meaſure, and ſure *infinite Wiſdom*, *Simplicity*, and *Unity*, muſt accompliſh all it's Works, with the moſt

Conſummate Harmony, *Proportion*, and *Regularity*. And this is the following Parts of this Treatiſe for Brevities ſake, we ſhall call the ANALOGY OF THINGS.

Lemma II.

This ANALOGY OF THINGS duly inſtituted, is as certain a *Demonſtration* of the *Exiſtence*, and *Wiſdom* of the Author of theſe Things, and of the Contriver of this *Analogy*, as alſo of the true Nature and Qualities of theſe Things diſcovered by this *Analogy*, as any *Mathematical Demonſtration*, is of the Propoſition propoſed.

Demonſtrat. No effect can be, without it's proper Cauſe, a wiſe and regular Effect muſt be produced by a wiſe and intelligent Cauſe, and an *infinitely Wiſe*, and *infinitely complicated* Effect, muſt neceſſarily imply an *infinitely Wiſe*, and *Omniſcient* Cauſe. Theſe are ſo certain and infallible *Axioms*, that I know not if in all the Compaſs of Humane Knowledge, any others come up to the ſame Degree of Evidence: And he can be no proper Subject of *Philoſophy* or *Mathematicks*, who cou'd ſeriouſly deny them, ſince the whole Evidence of both theſe Sciences, ſuppoſe the firſt of theſe *Axioms*, and the reſt are but like multiplying both ſides of the ſame *Equation* by the ſame terms, I have already obſerved, that the *Wiſdom* of an *Effect*, or Syſtem of Effects, conſiſts in the Proportion or *Analogy* of the ſeveral Parts to the whole and to each other, and of the whole, to the end propos'd; and that irregularity and no Proportion, is the ſureſt Evidence of Want of Contrivance, Wiſdom and Deſign. Now ſince the ANALOGY OF THINGS, juſt now Demonſtrated, to be found in all the Works of Nature, in the whole, in every the moſt Minute Part: And in theſe, Inſtances of this *Analogy*, without Number, and without End. (Every new Step in the Knowledge of Nature diſcovering freſh Inſtances of this *Analogy*) all theſe, I ſay, do neceſſarily infer, an *infinity of infinitely Wiſe* Effects; and therefore theſe Effects, muſt as neceſſary infer the Exiſtence of the *Author* of theſe Effects, and the Wiſdom of the Contriver of this *Analogy*, as an Effect infers it's Cauſe; that is, as certainly as any *Mathematical* Demonſtration infers it's Propoſition; ſince it's certainty depends on the Connexion between Cauſes and Effects, and the Truth of this *Analogy* in general. I ſay in the next place, that the true Nature and Qualities of theſe Effects or Things, diſcovered by this *Analogy*, duly Inſtituted, may be as certainly concluded from this *Analogy*, as any *Mathematical* Demonſtration, concludes its Propoſition. *Mathematicks* and *Philoſophy*, ſo far as they are juſt and genuine, are but Branches of this *Analogy*. *Mathematicks* are but this *Analogy* apply'd to *Figures* and *Numbers*. *Philoſophy*, properly ſo call'd, is but this *Analogy* apply'd to Bodies, or *Syſtems* of theſe; or to the abſtracted Natures of Things. Both, ſuppoſe the Truth and Neceſſity of this *Analogy*, without which they are but *Jargon* and *Romance*. An Inſtance or Two will make the whole Matter clear. Suppoſe it were required, to find the *refracted Ray*, when the *refractive Powers* of the Two *Mediums*, with the Inclination of the *incident Ray* on the *incident Plane*, are given. Let us borrow a *Corollary* from this *Analogy* of Things, to wit, that the diſtance between any fix'd Point in the *Incident*, and another in the *refracted Ray*, (the *refractive* Powers of the Two *Mediums* being regarded,) is the ſhorteſt poſſible; and with this *Corollary*, make an exact Computation; we ſhall then find the *refracted Ray* preciſely the ſame with that found out, from other different Principles and Methods (ſuppoſe of *Trigonometry*) where this *Corollary* has had no place, as the *Geometers* have ſhown. This *Phyſical Demonſtration* of this particular property of Light, (to wit, that in all *Incidences*, the *Sine* of the *Angle* of *Incidence*, is to that of *Refraction*, in a conſtant *Ratio*) ariſing from this *Analogy*, is as certain a Proof of the Exiſtence, and Wiſdom of the *Contriver* of this *Analogy*, as alſo of the true Nature of Light, (as to this particular property) as any *Mathematical* Demonſtration (ſuppoſe that by *Trigonometry*) is of the true Nature of the *incident* and *refracted Ray*. For who but an *omniſcient Artificer*, cou'd contrive Light ſo? That among all the infinitely different poſſible ways, between Two aſſign'd Points, it ſhou'd ſingle out that one, which is the ſhorteſt? And it is certain that the *refracted* Ray, is as truly found out by Virtue of this *Analogy*, as by any other more *Geometrical* Method. Another Inſtance may be taken from the regular and harmonious Progreſſions of *infinite Series's*; for Example, in the Powers of the *Binonimal* Root, $\overline{a+y}|^{n} = a^{n} + n a^{n-1} y + n \times \frac{n-1}{2} a^{n-2} y^{2} + n \times \frac{n-1}{2} \times \frac{n-2}{3} a^{n-3} y^{3}$ *&c.* or the *Series* produced by Diviſion $\frac{1}{1-n} = 1 + n^{2} + n^{3} + n^{4}$ *&c.* In a Word, every particular *Problem* in *Algebra* and *Geometry*, might be brought as Inſtances of this beautiful *Analogy* of Things, and thoſe who are converſant in the more abſtruſe Speculations of *abſtract Geometry*, can furniſh themſelves with Inſtances, ſo ſurprizing and extraordinary, of the Conſtancy of Nature in this beautiful Harmony, and comely Proportion, even in the largeſt Computations and moſt complex Conſtructions, as far ſurpaſs theſe Inſtances I have brought. Now what but an infinitely wiſe Being, cou'd have conſtituted the *Intellectual Species* of Things, ſo admirably? That all the Terms of theſe Progreſſions ſhou'd thus go on in ſuch regular and harmonious Proportions that every ſucceeding Term ſhou'd be made up of the preceeding ones, modify'd after one conſtant way, that by the caſt of an Eye, the ſaid ſucceeding Term ſhou'd be aſſign'd? whereas they might have been ordered, other infinitely different ways, ſo as to have afforded no regular Progreſſion. And does not this *Analogy* and harmonious Progreſſion of theſe *Series's*, as certainly give the ſucceeding Terms, as the actual Operations of *Algebra* do? Many more, and yet infinitely more ſurprizing Inſtances of this beautiful, *Analogy* and of the Inferences drawn from thoſe aſſign'd, might be given. But theſe may ſuffice for an Illuſtration of this *Lemma*.

Lemma III.

The Rules which ſeem naturally to ariſe for the due Inſtitution of this *Analogy* of

Things, may be reduced to theſe Three, *1.* That the Quality, Property or Idea, on which the *Analogy* is Inſtituted, be as ſimple and one, as poſſibly may be; and intirely the ſame, both in the known and unknown Subjects of the *Analogy*. Thus when we reaſon from the Nature and Properties of *Light*, and *Gravity*, on our *Earth*, to the Nature of *Light*, and *Gravity* in the *Planets* and *Comets*. We muſt ſeparate theſe into their moſt ſimple *Ideas* and *Properties* (to avoid Confuſion) as much as may be, and Inſtitute an *Analogy* for each, to diſcover if the *Analogy* hold good in the complex, and preciſely keep to the ſame *Properties* in the *Planets* and *Comets* the unknown Subject of the *Analogy*, as were ſuppoſed in the *Earth*, the known ſubject of the *Analogy*. Elſe we ſhall run into Confuſion and *Paralogiſm*. 2. The neceſſary Limitations ariſing from the different Circumſtances of the Two Subjects of the *Analogy*, as far as they may be known, muſt be cautiouſly and carefully taken into the State of the Queſtion. Thus in the firſt Inſtance, aſſign'd in the Second *Lemma*, if the different *refractive Powers* of the Two *Mediums*, had not been preciſely entered into the *Equation*, the Concluſion muſt have prov'd different from that found out by other Methods. Thus alſo in reaſoning from the manner of *Generation* in *Animals* to that of *Vege-*

Vegetables. If the Limitations ariſing from the different Circumſtances, and orders of Being, in theſe Two Subjects of the *Analogy*, be not carefully taken into the reaſoning, the Concluſions muſt prove falſe and erroneous. 3. Both the Subjects of the *Analogy* muſt be known and examined into, as far as may be, in regard to the other Qualities different from thoſe, the *Analogy* is inſtituted upon: But eſpecially the known Subject of the *Analogy* muſt be as fully known as is poſſible, in regard to thoſe Properties, on which the *Analogy* is inſtituted. Thus the more fully we underſtand the Nature and Qualities of our *Globe*, eſpecially as to *Light* and *Gravity*, and of the *Comets* and *Planets* as to their other Qualities, the more full and perfect ſhall our Concluſions be in regard to theſe aſſign'd Qualities, in the *Planets* and *Comets*: The more fully we underſtand the Circulation of the Fluids in *Animals*, the more aptly ſhall we apply them to *Vegetables*. Theſe Rules duly obſerved will render the Concluſions drawn by Virtue of this *Analogy of Things*, as certain as any *Mathematical* Demonſtration whatſoever.

Propoſition IX.

The *Viſible*, *Intellectual*, and *Created Species* of Things, are Pictures, Images, and Repreſentations, of the *Inviſible*, *Architypal*, and *Increated Species* of Things in the Mind of the ſupreme Being.

Demonſtrat. This is evident from *Lemma* 1. and 2. For ſince it is certain, that there are to be found in all the Works of Nature a beautiful Harmony, a comely Proportion, and an exact Symmetry running thro' the whole. And ſince this *Analogy of Things*, neceſſarily infers the Exiſtence of the Author of theſe Things, and the Wiſdom of the Contriver of this *Analogy*. Theſe Things and this *Analogy*, cou'd come from nothing elſe but from their original *Ideas* and *Archітypal Patterns*, in the *Divine Mind* or *Imagination*, and their Harmony and Proportion, can poſſibly ariſe from nothing but their being Repreſentations of his *Ideas*, who is omniſcient, and does every thing in *Number*, *Weight*, and *Meaſure*. There being no other poſſible way they cou'd be contrived; and he being *Supreme* and *One*, cou'd find nothing without himſelf that they ſhould repreſent. Beſides, it is abſolutely impoſſible, that infinite Power and Perfection, ſhou'd bring any thing into Being, that had not his own *Signature*, Stamp, or Image on it, for there cou'd be nothing beſides *himſelf*, whoſe Images they ſhou'd be; and it is abſurd to imagine they ſhou'd repreſent nothing at all. Therefore of neceſſity, they muſt be Pictures, Images, and Repreſentations of their *Ideas* and original Patterns, in the Mind of the Supreme Being. q. e. d.

Corollary I.

Hence it is evident that the *Viſible*, *Intellectual*, and *Created Species* of Things, are Images, Pictures, and Repreſentations of the *Divine Attributes*, more or leſs perfect, according to their Order in the rank of Beings. For ſince they are Images of the *Archytypal Ideas* in the *Divine Mind*, or *Imagination*, and ſince there was nothing without him, to beget theſe *Ideas*, and Nothing but his own infinite Perfections, that cou'd repreſent themſelves to him, in order to make theſe *Ideas* ariſe in his Mind. Therefore of neceſſity, they muſt repreſent his *Attributes* or *Perfections* the only thing he cou'd have to copy out.

Corollary II.

Hence it is evident, that with proper Limitations ariſing from the *Infinitely-infinite* diſtance; (ſo to ſpeak) between Finite and *abſolute Infinite* we may reaſon *Analogically* from the Nature and Attribute of the *Supreme intelligent Being*, to the Nature and Properties of *Finite intelligent Beings*; and from theſe to thoſe; to wit, by ſuppoſing theſe laſt Images, Pictures, and Repreſentations at an infinite Diſtance of the firſt.

Propoſition X.

A *Mathematical* Point, and infinite Space are the Two *Limits* of natural or created Things, as to Quantity or Extenſion, in Aſcending or Deſcending from Finite. And neither of them is any Part or Multiple of the other.

Demonſtrat. This is evident from *Prop.* 8. for natural or material Things can have no more Dimenſions than Three, and therefore the biggeſt Extreme in Created things, can riſe no further by the *Analogy* of things than to ∞ raiſed to the Third Dimention. And ſince infinite Space is as ∞^3, therefore infinite Space is the biggeſt Extreme, or Limit of natural Things aſcending from Finite. And ſince a *Mathematical* Point is the ſurface (ſo to ſpeak) of the Extremity of a *Mathematical* Line, which has but one Dimenſion, it muſt of neceſſity be the leaſt Extreme, in deſcending from Finite: In a Word, we can riſe no higher in natural and material things than infinite Space, ſince that is the *Locus Univerſalis* of all created Beings. And we can deſcend no lower than a *Mathematical* Point, ſince every thing below it (if poſſible) cou'd have no place at all, or wou'd be no where, that is, wou'd be abſolute Nothing. And neither of them can be any Part or Multiple of the other, ſince no number of Points, no not even an infinite Number, can make any real natural Quantity, not ſo much as a *Mathematical* Line, therefore *&c.* q. e. d.

Corollary I.

Hence a *Mathematical Point* and *univerſal Space* are true and genuine Oppoſites in Nature, and in the *Analogy* of Things, and between theſe Two Ly all created finite Subſiſtences. No natural Thing can be bigger than *infinite Space*, and no natural Thing can be leſs than a *Mathematical* Point, they differ the moſt widely that natural Things poſſibly can, and have nothing common but *Entity*, and ſo are true and genuine Oppoſites.

Corollary II.

Hence in the *Analogy* of Things, *Matter* cannot be Infinite, in any ſenſe of Infinite aſcending from Finite. For ſince *Matter* is of thoſe natural Things, that neceſſarily require all the Three Dimenſions, were it Infinite, by the *Analogy* of Things, it wou'd neceſſarily be as ∞^3, that is, it wou'd be equal to infinite Space, but ſince the neceſſity of a *Vacuum* has been Demonſtrated in

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the firſt *Chapter of the firſt* Part, it cannot be equal to infinite Space, and ſince it cannot be Infinite any wiſe but as infinite Space, by the *Analogy* of Things. Therefore *Matter* cannot be Infinite, in any ſenſe of Infinite aſcending from Finite.

Propoſition II.

Abſolute Nothing, upon a real Quantity produces no Effect at all. Or *Abſolute Nothing* can be ſuſceptible of none of theſe *Arithmetical* Applications, to which, real Quantities are ſubjected.

Demonſtrat. Suppoſe abſolute Nothing upon a real Quantity, cou'd produce any Effect. Let the real Quantity be a and the Effect m, then abſolute Nothing $\times a = m$ that is, abſolute Nothing is equal to $\frac{m}{a}$, that is, abſolute Nothing is a real Quantity, as $\frac{m}{a}$ is, which is abſurd. Now ſince abſolute Nothing multiplyed into a real Quantity can produce no Effect, for the reaſon and by the Argument now aſſign'd, neither can it, when divided by a real Quantity, by the ſame way of reaſoning, ſince Diviſion by a, is the ſame with Multiplication by $\frac{1}{a}$. And ſince, Multiplication and Diviſion are the ſame with Addition and Subſtraction reiterated as often as the Multiplicator and Diviſor implies: Therefore *abſolute Nothing* is ſuſceptible of none of thoſe *Arithmetical* Applications that real Quantities are ſubjected to: q. e. d.

Corollary.

Abſolute Nothing therefore, when apply'd to real Quantities by Multiplication and Diviſion (and conſequently, when by Addition and Subſtraction) implies, that there is neither Product nor Quotient, *that is*, that the real Quantity is neither Multiplied nor Divided, but remains unaltered.

Propoſition XII.

In the *Analogy* of Things; as a *Mathematical Point* is to *univerſal Space*, ſo is *abſolute Nothing* to the *abſolute and ſupreme Infinite.*

Demonſtrat. By *Prop.* 10. a *Mathematical Point*, and *univerſal Space*, are the Two *Limits* of material or natural Things: they involve ſimple, clear, and diſtinct Ideas, and are as well known, as any of the Objects of Human Knowledge. *Abſolute Nothing* is one of the Limits of the *Univerſitas rerum omnium*, to wit, that in deſcending, below which nothing can fall; and therefore by the Rules laid down, for the *Analogy* of Things, the *abſolute* or *ſupreme Infinite* muſt be the other Limit, beyond which nothing can riſe in Aſcending, and between theſe Two, all *Subſiſtences*, Finite, Indefinite, and relative Infinite are concluded. Wherefore by *Lemma* 3. and *Prop.* 9. as a *Mathematical Point*, *&c.* q. e. d.

Corollary I.

Hence *abſolute Infinite* can neither be encreas'd nor diminiſh'd. For *abſolute Infinite* and *abſolute Nothing* being the *Limits* of all Things whatſoever, *abſolute Infinite* muſt be the greateſt of all Things, and ſo can neither be encreas'd nor diminiſhed, elſe it cou'd neither be the *Greateſt*, nor the aſcending *Limit*.

Corollary II.

Hence *abſolute Infinite* is *One*, and *Individual*. Becauſe being neither capable of encreaſe nor diminution, and being the aſcending *Limit*, it muſt be One: And Individual, becauſe there can be no other like it, it being the One aſcending *Limit*.

Corol-

Corollary III.

Hence *abſolute Infinitude* is only compatible to the Divine Nature, and to nothing elſe. He being the greateſt of all Beings, *One*, and *Individual*, or the ſingle poſſible Being of the ſame Nature.

Corollary IV.

Univerſal Space, is the Image and Repreſentation in Nature, of the *Divine Infinitude*, for ſince by *Prop*. 9. the created *Species* of Things are Images of the Increated, and by *Prop*. 10. *univerſal Space* is the *greateſt* Limit of the viſible Creation, or material *Syſtem* of Things. Therefore *univerſal Space* is the natural Image of the greateſt Limit of all Things, or of the *Univerſitas rerum omnium*. That is, by *Prop*. 12. and the *preceeding Corollary*, *univerſal Space* is the natural Image of the *Divine Infinitude*.

Corollary V.

Hence *univerſal Space* may be very aptly called the *Senſorum Divinitatis*, ſince it is the Place wherein all natural Things, or the whole *Syſtem* of material and compounded Beings, are preſented to the *Divine Om-*

niſcience. Infinite Space is the Image of the *Divine Infinitude*, wherein as in a Picture of Him (in whom all things Live and move and have their Being) all created Things preſent and manifeſt themſelves to, the intuitive View of the *ſupreme Infinite*, and therefore in the *Analogy* of Things, Infinite Space is to the *ſupreme Infinite*, what a Humane *Senſorium* may be ſuppoſed to be to Men.

Corollary VI.

An *abſolute infinite Creature* is a Contradiction, becauſe *abſolute Infinite* is *One* and *Individual* by *Corollary* 3. of this.

Scholium.

One very remarkable difference between *Finite, Relative and abſolute Infinite* is this. *Finite* may ſtill be encreas'd by it ſelf, and yet continues it's finite Nature, 'till the Number of Additions be actually Infinite. *Relative Infinite* may be encreaſed, not by Finite, but by *it ſelf*, and ſtill continues it's Nature, after *Infinitely-infinite* Additions, without Bounds or Limits: For let it be ever ſo often encreas'd by it ſelf, it continues but *relative Infinite*. But *abſolute Infinite* can be encreas'd by nothing, not even by it ſelf, elſe it cou'd not be the abſolute or greateſt Infinite. In natural Things *finite*, and *relative Infinite* never riſe higher than the Third Power. The *Comets* and Planets move in *Orbits*, that are *Curves* of the *Second Power*. *Projectiles* move in *Parabolick* Lines, which are of the ſame Order. The *Curvature* of the *Surface* of all the *Celeſtial* Bodies are of the *conical-Section-kind*. The *Surfaces* of Fluids, riſing in great or ſmall Channels, are of the ſame rank. Nature admits but of Three Dimenſions, and I know of no natural Effect, that riſes higher than the Third Power. Even the *irrational Curves* that Nature forms, in conducting *ſolid Bodies*, and the *Rays of Light* (thro' different *refracting Mediums*) the ſhorteſt and eaſieſt way: And in ſome other of her Operations, ſuch as the *Cycloid*, *Conchoid*, *Catenaria*, *Velaria*, *Curva Elaſticitatis*, *Logarithmica*, the *Spiral* and the like, all of them are of the loweſt rank of their Order: And their Natures imply only Portions of *Curves*, or of their *Areas*, of the *Conical-Section-kind*, the loweſt Order of all *Curves* whatſoever. So true it is that Nature perpetually brings about her Purpoſes *the ſhorteſt and ſimpleſt way*, and keeps conſtant to this beautiful *Analogy* of Things. But ſince Quantity may be ſtill encreaſed, ∞ may be ſuppoſed to riſe to higher Powers than

∞^3 in the intellectual *Species* of Things, ſuch as are, ∞^4. ∞^5. ∞^{∞}. $\infty^{\infty^{\infty\,\&c.}}$ Now tho' theſe Powers of ∞ ſuperior to ∞^3, can have no Place in natural Things, or the material *Syſtem*, yet are they the *intellectual Species* of created Things, and are in their reſpective Orders, *Images*, and Repreſentations of their *Architypal Ideas*, in the Divine Mind, and Inſtances of the unexhauſtible Store, of manifold Wiſdom, in the Divine Nature. And as *infinite Extenſion* is the Image in Nature, of *abſolute Infinite*, ſo $\infty^{\infty^{\infty\,\&c.}}$ is the Image of the ſame abſolute Infinite, in the *intellectual Species* of Things. And by the *Analogy* of Things, relative Nothing, and relative Infinite are the *intellectual Images* of *abſolute Nothing* and *abſolute Infinite*, ſo univerſally does this *Analogy* hold good.

Propoſition XIII.

Abſolute Infinite, in the *Analogy* of Things, is the preciſe and proper Oppoſite to *abſolute Nothing.*

Demonſtrat. This is plain from *Prop.* 12. and it's *firſt Corollary*. For ſince a *Mathematical* Point, is the preciſe and proper Oppoſite to univerſal Space, and ſince in the *Analogy* of Things, a M*athematical* Point is to *infinite Space*, as *abſolute Nothing* is to *abſolute Infinite*: Therefore *abſolute Infinite* is the preciſe and proper Oppoſite to *abſolute Nothing*. Beſides, *abſolute Nothing* and *abſolute Infinite*, being the *Limits* of the *Univerſitas rerum omnium*, in Aſcending or Deſcending from created Finite Beings. They muſt be preciſe and proper Oppoſites, having nothing common but their being *Entia and Limits.* q. e. d.

Corollary I.

Since *abſolute Nothing*, in it's poſitive *Idea* implies the utmoſt impoſſibility of, and the moſt extreme Contradiction to *reality* or real Being, as it moſt certainly does, for it is not poſſible to conceive a greater Contradiction to, or impoſſibility of *Reality* or real Being, than is imply'd in the poſitive Idea of *abſolute Nothing* or *Non-entity*, beyond which there is no further deſcending from Reality or Being. (It having no real *Entity*, tho' it may be claſs'd, as to it's negative Conception, in the *Category* of *Entia rationis*,) Therefore by the *Analogy of Things*, *abſolute Infinite* muſt imply in it's poſitive *Idea*, and that neceſſarily, the utmoſt poſſibility, and the moſt extreme neceſſity of *Reality* or real Being.

Corol-

Corollary II.

Wherefore ſince *abſolute Nothing*, in it's poſitive *Idea* implies the utmoſt Contradiction to real Being, ſince *abſolute Infinite*, is the preciſe Oppoſite to *abſolute Nothing*, ſince alſo being Oppoſite in every thing (except as *Entia* and *Limits*, which do not effect the Realities in *abſolute Infinitude*, as to it's poſitive *Idea*) *abſolute Infinitude*, muſt imply in it's poſitive *Idea*, the utmoſt neceſſity of *Reality*, or real Being, therefore of neceſſity the *abſolute Infinite* muſt really *Be*, or the Being to which *abſolute Infinitude* is only compatible, muſt neceſſarily exiſt.

Propoſition XIV.

Finitude and *Infinitude*, when apply'd to natural and created Things, in their poſitive *Ideas*, imply not *Realities*, but the *Modes* of *Realities*.

Demonſtrat. *Finitude*, when apply'd to natural or created Things, imports only in it's poſitive *Idea*, the Proportions of the ſeveral Degrees of *Affections*, or *Properties* of theſe Things to one another. *Infinitude*, the unboundedneſs of theſe Degrees of *Affections*, or *Properties*. *Finitude* and *Infinitude*,

tude, in themſelves, abſtracted from a proper Subject or *Subſtantive*, are incomplete *Ideas* in natural or created Things. *Infinite Extenſion*, *Number*, *Duration*, *Wiſdom*, *Knowledge*, *&c.* are complete *Ideas*, whereof theſe *Realities* are the Subjects or *Subſtantives*, and the *Infinitude*, the *Epithet* or *Adjective*: Wherefore *Finitude* and *Infinitude* in natural or created Things, being but *Adjuncts* to *Realities*, in their poſitive *Ideas*, do not imply *Realities*, but the *Modes* of *Realities*. q. e. d.

Corollary I.

Hence the *Modes* of natural or created Things, are *Realities*, in the ſupreme or *abſolute Infinite*, or the *Modes* of natural or created Things, when *Analogically* elevated to the ſupreme, and *abſolute Infinite*, are in him not *Modes*, but the utmoſt *Realities*. This is plain from the *preceding Propoſition*, and the 2*d Corollary* of the 13. *Infinitude* is but a *Mode* in natural or created Things, but in the ſupreme or *abſolute Infinite*, it implies in it's poſitive *Idea*, the utmoſt *Reality*, to wit, neceſſary Exiſtence; and the ſame muſt of neceſſity be true, in all thoſe Attributes of the Divine Nature, which *Analogically* deriv'd down to the Creatures, are in them but *Modes*, in him they are the utmoſt *Realities*; becauſe they are all complicated and affected with, or (ſo to ſpeak) multiplied into *abſolute Infinitude*, which *realiſes* thoſe *Modes* of Creatures, and *Tranſubſtantiats* them into poſitive and *real* Qualities. So true is the *Metaphiſical Axiom, quicquid in Deo, ipſe Deus eſt.* I do not here contend that there may not be *acceſſory Ideas*, in the Divine Intellect, or that there may not *Arbitrarily* ariſe in the Divine Intellect, *Images* of Beings, whoſe Exiſtence is Fact, is not neceſſary. Since the *Idea* of a Creature, cannot be neceſſary to him, elſe they would neceſſarily be. But even thoſe *Acceſſory* or *Arbitrary Ideas*, in the Divine Imagination, by being there, become of a quite different Nature from the like in Creatures, for by being there, they (by Virtue of his *abſolute Infinitude*) receive a Being infinitely ſuperior to the like *Ideas* in created Beings, not neceſſarily, but with infinite Freedom and Liberty. And thoſe Affections and Properties in *Creatures*, which in them are but *Modes*, when *Analogically* carried up, to the like or ſimilar Affections or Attributes in the Divine Nature, are in him the utmoſt *Realities*, as being complicated with *abſolute Infinitude*, and thereby transform'd or exalted into real Quantities or actual Subſiſtences.

Corol-

Corollary II.

Hence, *Power*, *Subſiſtence*, *Duration*, *Knowledge*, *Wiſdom*, *Goodneſs*, *Beauty*, *&c.* which in created intelligent Beings, are the Images of *Omnipotence*, *Neceſſary Exiſtence*, *Eternity*, *Omniſcience*, *the Divine Sophia*, *Benignity*, *infinite Perfection*, *&c.* in the Divine Nature: And are but M*odes* of Being, and not eſſential affections in theſe, are in him infinite R*ealities*, and living active Principles. And he that wou'd reaſon *Analogically*, from the Nature of theſe in created intelligent Beings, to the Nature of thoſe in the Divine Eſſence, without having the utmoſt regard to the *abſolute Infinitude*, which in a manner quite changes the Nature of the former, and exalts them into a different *Category*, wou'd be miſerably miſtaken. For Inſtance, he that, becauſe the Duration of natural Things is Succeſſive, wou'd conclude ſo of the Divine *Eternity*: He that wou'd reaſon becauſe humane Power cannot give Being and Subſtance to that which had none, the Divine *Omnipotence* cou'd not: He that wou'd infer, that becauſe the Knowledge of Rational created Beings is *Progreſſive*, the Divine *Omniſcience* were alſo Progreſſive, muſt be egregiouſly miſtaken: Becauſe in this *Analogy* he does not take in the *abſolute Infinitude* which elevates and exalts the Duration Power and Knowledge of created Things, into a Degree of Reality of which theſe are but the Images or Pictures. He that from the Picture of a Man, wou'd *Analogically* reaſon about Humane Nature, from the blending and poſition of ſome Colours on Canvaſs, wou'd reaſon to Life, and Knowledge: Or from the reflected Image of the Sun in Water, wou'd conclude of Light, and Heat, cou'd not err more groſly.

Scholium.

In intelligent compounded Beings: The *Powers* belonging to the Body, are not only Finite, but very low in the Order of Finites. The *Eye* perceives not diſtinctly a very large nor ſmall Object. Too ſtrong a Noiſe ſtuns the *Ear*, and one too weak does not act upon the *Organ*: Neither of them produces a diſtinct Hearing; and it is ſo in all the other Senſes. Thoſe *Organs* are ſo contriv'd, as to perceive beſt the ordinary Effects of common Life, the Objects that neceſſity of Subſiſtence do moſt readily preſent to us. Theſe they are fitted for, and little elſe; they have a wonderful Facility in manifeſting theſe diſtinctly to our Minds, and have a juſt Proportion to the Objects about us, but ſeem not contriv'd nor deſign'd for Curioſity, or conveying much more Knowledge to us, than what the conveniencies of Life require: Elſe infinite Wiſdom and Power might have eaſily formed them ſo, as not to need thoſe help and aſſiſtances, which we are obliged to employ when we aim at any more particular Knowledge of the intimate Natures of the Things about us, than conveniency makes neceſſary or commodious. The *Faculties* belonging to the Rational Soul are likewiſe Finite, but of a higher rank of Finites than thoſe Powers belonging to the Body. The *Imagination* can paint a larger *Idea*, than the *Eyes* can ſee, and the *Memory* lodge a greater ſtore of Images, than all the Senſes can preſent at one time: And the Underſtanding can combine and disjoin theſe, and compare them many different ways: But ſtill theſe Faculties are but Finite in their *Capacity*. We can form no diſtinct Ideas of *Millions* of *Millions*, of a *Multiangular Figure*, or any *relative Infinite*, ſmall or great: The Imagination ſeems not able to contain theſe; there is no room on it, for ſo large Pictures. The *Memory* is the *Repoſitory* of the Images that have been framed on *Phantaſy*, and can go no further than it reaches; nay ſeldom or never contains more than a ſmall part of thoſe. The *Underſtanding* can work no further than theſe two afford Materials; it's Works being to *Collate*, *Combine*, and *Garble* as it were, theſe Images and *Ideas* the *Imagination* and *Memory* preſent to it. All theſe are Limited, as the Senſes are, tho' not quite ſo ſtraightly, becauſe the *Underſtanding* may variouſly combine thoſe *Idea's* they have convey'd to the *Imagination* and *Memory*, and ſo encreaſe their Number: And the *Will* having no ſubject Matter to proceed upon, but as it is prepared by theſe prior Faculties, can go no further than thoſe allow it. The Underſtanding may diverſify theſe as far as their *Combinations* will reach, and the *Will* may pick and chooſe among theſe, but ſince it cannot *create* Objects for it ſelf to work on, it muſt be Limited to the Images and *Ideas* on the *Imagination* and in the *Memory*. The *Will* I mean, as it is Faculty belonging to the *Rational Soul*. All theſe Faculties ſeem to have been originally deſign'd for Nothing but this *material World*, and the Syſtem of Things about us. They help us to no Notion or Conception of any ſort of Beings diſtinct from *Matter*, but in ſo far as *Analogy* will bear us out, and even as to the *material World*, they ſeem fitted for little elſe, beſides the groſſer, more general and more neceſſary Knowledge of Things that are required for due Conveniency, or Subſiſtence,

ſiſtence, and ſhow but ſome of the groſſer *out-lines* of the real Natures of Things. Every thing that might violently entertain our Curioſity, or flatter our Vanity, as to the Knowledg of the Natures of Things: Seems to have been induſtriouſly conceal'd from us, and no Faculties to have been indulged us, for theſe purpoſes, leaſt they ſhou'd have withdrawn us too ſtrongly, from things of greater Moment to the end of our Being: Elſe infinite Wiſdom and Power had contriv'd them after a more perfect Manner, with a larger *Capacity*, and a ſtronger *Energy*. As to the Faculties of the *ſupreme Spirit*, (which is a third Part of intelligent compounded Beings) they moſt certainly are infinite in their *Capacity* and *Energy*, I mean they may be enlarged and encreaſed without Bounds or Limits, which by *Def.* 4. is to be relatively Infinite. Not only the *Acts* of theſe Faculties may be Multiplyed perpetually, but the *Capacity* and *Energy* of theſe, may be dilated and intended without Bounds or Limits. The *Perception*, the *Deſires*, the *Will*, (the Faculties belonging to the *ſupreme Spirit,)* are unlimited and boundleſs, fitted and deſign'd for *infinite Objects*. Theſe indeed are the firſt, *Principal*, and *Original* Faculties, belonging to all compounded intelligent Beings: By which they are made capable of Communicating with the *ſupreme Infinite.* And next in order of Nature to the *ſupreme Spirit,* is the *Rational Soul,* whereby they are enabled to communicate with the *material World:* And to the Faculties of this *Secondary* Part of the Compoſition, the Senſes of the Body are the *Conduits,* and Conveyances, which make up the Third and laſt part of compounded intelligent Beings: In the due *Subordination,* the perfect *Harmony,* and perpetual *Concord* of theſe Three, with each other, the *Perfection* of theſe Beings does conſiſt: In their *Diſcord, Confuſion,* and *Rebellion* one againſt the other, their *Degeneracy, Corruption,* and *Fall.* It can be no difficulty to thoſe who are acquainted with the *Analogy* of Things, to conceive how theſe ſeveral parts of compounded intelligent Beings are contain'd without Confuſion or Contrariety in each other; in their Primitive and uncorrupted State: When they conſider, that in Water is contain'd Air, in that *Æther,* in that Light, and perhaps in this laſt, a more ſubtle and refin'd *Spirit;* and all theſe in perfect *Harmony,* and *Concord.* But to conſider theſe a little more particularly. The *Perception,* as it belongs to the *ſupreme Spirit,* muſt of neceſſity be a *paſſive* Principle, becauſe it cannot create it's Objects, but receive thoſe preſented to it: That it is Infinite, is plain, becauſe it's adequat Object is Infinite, and the *ſupreme*

ſupreme Infinite: It being beſtow'd on intelligent Beings, in order to Communicate with the *abſolute Infinite.* The neceſſity of this Third Part of the Compoſition of the mention'd Rank of intelligent Beings ſhall be afterwards Demonſtrated; I proceed to conſider in a few Words, the Nature of ſome others of theſe Faculties, belonging to the *ſupreme Spirit.*

Propoſition XV.

The *Deſire* is Infinite in it's *Capacity*, the moſt *Cardinal*, moſt *Quick*, and *Senſible*, and moſt *Active* Faculty of the *Mind* or ſpiritual part of compounded intelligent Beings, and the *Will*, and the *Affections* are but *Modifications* of it.

Demonſtrat. To be convinced of the Truth of this *Propoſition*, we need only reflect on the Source of all the Happineſs or Miſery of intelligent Beings, and we ſhall find it ariſes from the enjoyment or diſappointment of their *Deſires.* There is in all intelligent Beings, a reſtleſs *Appetite* or *Deſire* of Happineſs: From the Moment of their Being, though all the Ages of Eternity, all their *Labour*, and *Travel*, is for this purpoſe: Nor are they devoid of it, either immediately in the *End*, or mediately in the *Means*, for one inſtant of time, in all their endleſs *Duration.* Now this is the neceſſary Effect of the Faculty of *Deſire*, no Object leſs than *Infinite* can ſatisfy it. For let it be ſuppoſed to have come to the Poſſeſſion, of any Object leſs than *Infinite*, it's plain, it can *deſire* yet a greater, and a greater, without Bounds or Limits; that is, it can deſire an *infinitely great Object*, that is, the *Deſire* it ſelf, is infinite in it's *Capacity*; it's *Acts* are *Inſtantaneous*, and it's Enjoyments or Diſappointments, for a time, ſwallow up the *Acts* of all the other Faculties: And therefore it is the moſt *Quick* and *Senſible*: It ſets all the Powers of the whole Compoſition on Action, to obtain it's *Ends*, and therefore it is the moſt *Active:* And upon all theſe Accounts, the moſt *Cardinal* Faculty of the *Mind*: Chooſing or refuſing, that is *willing*, is but the Deſire apply'd to a particular Object; the *Affections*, are but the *Complexions* of the *Deſire*, as apply'd to this particular Object: And therefore are both but *Modifications* of the *Deſires*, wherefore, *&c.* q. e. d.

Scholium.

To apprehend how infinitely Capacious, Active, and Senſible the Deſire is, we need only imagine our ſelves, ſeparated from the Objects of Senſe, and the preſent *Amuſement* of *Life*, with all the Faculties of the Soul *awake*: And we ſhall then be able to conjecture, how *Strong*, *Active*, *Reſtleſs*, and *Unſatiable*, our Deſires wou'd be. So as to ſwallow up, and extinguiſh, all the other *Acts* of the Faculties of the whole compound. Thoſe only can moſt ſenſibly feel the force of this reaſoning, who have in ſome meaſure, and for ſome time been in this State.

Corollary I.

Since the *Deſire* is *Infinite* in it's Capacity, and may be dilated beyond any finite Object, how great ſoever, it is evident it cannot be over-fill'd, or ſuper-abundantly (ſo to ſpeak) ſatisfied, with any Object leſs than *Infinite*: Since alſo, the greateſt relative Infinite, cannot be aſſignable by *Corollary* 1. *Prop.* 1. Therefore the *Deſire* cannot be adequally and over-fill'd with any leſs Object than the *abſolute Infinite*; it being capable of being enlarged, beyond the Dimenſions of any *relative* or *creaturely Infinite* aſſignable: And ſince by *Corollary* 6. *Prop.* 12. no *Creature* can be *abſolutely Infinite*, therefore the Deſire can be perfectly and adequatly fill'd and ſuper-abundantly ſatisfyed, by nothing leſs than the *ſupreme* and *increated Infinite*.

Corollary II.

Since the *Deſire* is *Infinite*, when fill'd and ſatisfied with it's proper and *adequat Objects*, it muſt be infinitely Happy; for ſince nothing, by the *preceeding Corollary*, but the *abſolute* and *increated Infinite*, can adequatly fill, and ſuper-abundantly ſatisfy it. The *abſolute* and *increated Infinite* muſt be it's proper Object, and the *Deſire*, *infinite* in it ſelf, fill'd and perfectly ſatisfy'd with it's proper Object, the *ſupreme* and *increated Infinite*, muſt of neceſſity be infinitely Happy. Happineſs ariſing from the *Congruity*, of the Object with the Faculty, and this *ſupreme* and *increated Infinite* being the proper and indeed the only proper Object, (ſince the ſupreme Infinite is One) it muſt alone be the *Congruous* Object, and ſo the Faculty being *Infinite*, the Object *Infinite*, and they infinitely *Congruous* to one another. The *Deſire*, in the Poſſeſſion or Enjoyment of this Object muſt of neceſſity be infinitely Happy.

Propoſition XVI.

In regard of *intelligent Beings*, every thing that is in the *Univerſitas rerum*, may be fully comprehended, under theſe Three general Heads, to wit, the *Faculty* or *Deſire*, the *Object* of this *Faculty* or *Deſire*, and the *Senſation* ariſing from the *Congruity* or *Incongruity* between theſe two.

Demonſtrat. All the diſtinct Subſiſtences that actually exiſt, are comprehended under theſe two general Heads, the *ſupreme* and *abſolute Infinite*, and the *Creature*, and theſe can only be Objects of the *Faculty* or *Deſire*. The *Faculty* or *Deſire* being Infinite, by the *preceding Propoſition*, may contain or receive both theſe, and the *Senſation* ariſing from their *Congruity* or *Incongruity* to the Faculty, muſt together with theſe two general Heads mention'd, comprehend every thing in the *Univerſitas rerum* in regard to any particular intelligent Being. For nothing can be Imagin'd in the whole extent of Being, *Real* or *Intellectual*, that may not be reduced to *Faculty*, *Object*, or *Senſation* ariſing from theſe. Therefore, *&c.* q. e. d.

Propoſition XVII.

An *Intelligent Being*, compounded of a Body, Soul, and Spirit, with proper Relations, and in Subordination to each other, is a real *Epitome*, *Image*, or *Repreſentation*, of the *Univerſitas rerum omnium*.

Demonſtrat. This is ſo evident from the *Analogy* of Things; that there can be no difficulty in it, to thoſe who will conſider, that the *ſupreme Infinite* cou'd have nothing more perfect than Himſelf and his other Works, and his own perfect Adminiſtration and Government of theſe; to form this compounded Being upon. He muſt be conſiſtent with Himſelf, and his *compounded Works*, in their component parts, muſt reſemble in the *leſſer* Compoſitions, the *ſimilar* parts of the *Greater*. This *intelligent compounded Being*, being to have a *material* part, what can it have more worthy of the Work of infinite Perfection, than his *greater Syſtem* of material Beings to reſemble? His Soul or rational Part can reſemble nothing more worthy of *Him*, than the other higher Orders of created Spirits: And his *ſupreme Spirit* or Mind, will bear it's beſt reſemblance, when it repreſents the *ſupreme Infinite*. His Adminiſtration and Government of the whole *Syſtem* of created Beings, can be repreſented by nothing ſo aptly, as the Relations and Subordination of theſe to each other, and to the reſt of intelligent Beings, which theſe cou'd only be formed upon. In a Word, it is impoſſible that any *Idea* of a compounded intelligent Being, made up of ſeveral parts, each *Similar* to ſome greater part of the *Univerſitas rerum*, already exiſtent, cou'd enter to the divine Mind, which cou'd be more perfect and more worthy of *Him*, than this, that each inferior part ſhou'd be an *Epitome* and Reſemblance of his Works already made, and the higheſt part, of *Himſelf*, and that their Relations and Subordination, ſhou'd reſemble his Adminiſtration of the whole. I ſay it is impoſſible it ſhou'd be otherwiſe, to preſerve his Conſiſtency with himſelf, and to carry on this *Analogy*, through every individual part of his Works, through the whole *Scale* of Beings, as it moſt certainly is carried. And this is not a meer *Metaphorical* Picture, and Reſemblance, but the real and Phyſical Nature of compounded intelligent Beings. Wherefore, *&c.* q. e. d.

Corollary I.

From this Foundation, by a proper *Analogy*, with the due Limitations; all the *Relations* and *moral Duties*, of *intelligent compounded Beings*, to the *ſupreme Infinite*, to *ſimilar intelligent Beings*, and to *themſelves*, may be eaſily deduced; for Inſtance, do we reſemble the *ſupreme Infinite*, in our *ſupreme Spirit*: Then as he is the firſt in *Order* of *Beings*, ſo is this part of our Compoſition, the firſt and moſt principal, in our *Order* of Parts. All the reſt muſt be Subſervient and Subordinat in us, to this, as the reſt of the ſeveral Ranks of Beings, are to him: This we are chiefly and mainly to Cultivate, by fitting it up for him, for whom it was *originally* deſign'd and beſtow'd upon us. Here, we muſt aſpire after *Him*, and open our *Deſires* for *Him*, by a *Love* worthy of *Him*, ſuperior Infinitely, to all our other *Loves* and *Deſires*: On this part and it's Faculties, our Greateſt, our Chief, nay, and our only Labour is to be beſtow'd; that it may be Expanded, Dilated, and Elevated, to it's proper Rank in the *Order* of our Parts; that the due Subordination may be reſtored; which done, all the other Parts will perform their proper *Functions*, in *Harmony* and *Concord*. In regard to other *intelligent Beings*, we are to conſider them, as like *Images* of *Him*, and *his Works*; and follow them with a *Benevolence*, proper to ſuch *Images*, to imitate his Conduct of *Love* and *Forbearance*, to all his Creatures. But this only by the by.

Corollary II.

Hence, in a proper *Analogy*, the Nature of the *Spiritual*, and *Material* Parts of compounded intelligent Beings and of the *Union* between theſe, as far as they may be known by meer Humane Reaſon, is to be deduced. Compounded intelligent Beings, are *Epitomes*, or *Images* of the *Univerſitas rerum.* In their Bodies, they reſemble the *material Syſtem* of Things, in their *Spiritual Parts*, they reſemble the Spiritual World, the Union of theſe two is a reſemblance of, (or is maintain'd and preſerv'd after,) the Manner, the *ſupreme Being*, governs the *material Syſtem* of Things: Who being intimately preſent, with every individual *Atom* of Matter, yet more *eminently* acts from his ſuperior *Throne of Glory*, having the whole *Syſtem* of Creatures, in one View preſented to him, in the *univerſal Space*, his ſpecial *Senſorium.* By this Principle, as a *Key*, the whole *Phyloſophy*, of Humane Nature, of the Animal, Rational, and Divine Life, of the Paſſions, and Affections of the Soul, and even of the *Organiſm* of the Body, ſo far as it is Juſt and Genuine, and given to meer Humane Reaſon to know, is to be unlockt, and that not *Metaphiſically* but *Phyſically* and in Reality. But who is ſufficient for the detail of theſe Things?

Corollary III.

Hence, the *Immortality* of the ſpiritual Part, of intelligent compounded Beings, is evidently to be deduced. For ſince the *ſpiritual* Part, of intelligent compounded Beings, is an *Epitome*, and *Image* of the *ſpiritual*

ritual World; and the *ſupreme Spirit* (that part which God *originally Breath'd* into Man) is an *Epitome*, and *Repreſentation* of the *abſolute Infinite*; ſince by *Corollary* 2. *Prop.* 13. he *neceſſarily* exiſts, therefore the Soil, or *ſpiritual* Part (whereof this ſupreme Spirit is the *Fund* or *intimate Subſtance*) muſt exiſt for *ever*. Not neceſſarily, for that Concluſion, wou'd drop the proper Limitation, in the *Analogy*, ariſing from *abſolute infinitude*: But, as being *Images* of him, who exiſts *neceſſarily*, and having their Being from him. Their *Immortality*, is indeed an active, *living Principle*, not of neceſſary, (but *deriv'd*) Exiſtence. They are *Immortal*, as having repreſented on them, all his communicable Perfections; of which, *perpetual* Exiſtence is one, tho' *neceſſary* Exiſtence be not; that being contrary to *Creation*, or deriving a Being from another. *Immortality* in Creatures, is nothing but *perpetuity* of Exiſtence, and if Exiſtence at all be communicable to Creatures, *perpetual* Exiſtence muſt be communicable: For Exiſtence, being an *active*, *living Principle*, will of it ſelf continue *Being* for ever, unleſs it be deſtroyed: Which is impoſſible, both from the *Immutability* of *God*, and the Nature of his own *Immortality*, of which this is an *Image*, or *Reſemblance*. The *Immortality* of ſpiritual Creatures, is an *Emanation* from an *Image* of the divine communicable *Immortality*. And muſt reſemble every thing in it, but *neceſſity*, that being a Contradiction to it's being *deriv'd*. But in every other Circumſtance it perfectly reſembles the *Immortality* of the ſuperior Infinite, (as far as creaturely Properties can reſemble Divine Attributes) and ſo cannot poſſibly be deſtroyed: And this is the true ſource of the *Immortality* of all Creatures. It is true, this *Demonſtration* equally concludes the *Immortality* of all his other Works, ſince they are equally his *Images*, in a higher or lower Degree of Perfection: And without all doubt it muſt be ſo, *for the Gifts, and calling of God are without Repentance*. And this is the Genuine, and as the *Schools* call it, the *Apodeictick Demonſtration*, of the *Immortality* of all the Works of God, under ſome form or another, it is from their being his *Images* that their Immortality ſprings.

Corollary IV.

In the *Analogy of Things*, the *Deſire* being the *Cardinal* Faculty of the Soul, and *Infinite* in it's *Capacity*, is as the *Infinite Space*, to the *Divine Plenitude*: Which infinite Space, nothing created, can adequatly fill, but the divine *Plenitude*. And in this view, the *infinite Capacity* of the *Deſire*, may be conſidered as a *Boundleſs Void*, made to receive ſome *Fleeting*, limited Parts or *Syſtems* of Matter, acting by eſtabliſhed Laws, and in comely Order, upon one another for a while, but can never be perfectly fill'd, or adequatly repleniſh'd, but by the *ſupreme Infinite*: Who is preſent with, and repleniſhes every point of the great and *univerſal Void* of Nature.

Scholium I.

As in regard to intelligent Beings, the *Univerſitas rerum omnium*, is fully comprehended under theſe Three general Heads; the Faculty or *Deſire*, the *Object*, and the *Senſation* ariſing from the *Congruity* or *Incongruity*, between theſe. So the ſame *Analogy* with proper Limitations, is preſerved in the material *Syſtem* of Things. For anſwerable to theſe, we have in the *material World*, *Gravitation*, which wonderfully *Analogiſes* to the *Faculty* or *Deſire*, in the *ſpiritual World*, and this to that; both being the *Active*, *Cardinal*, and *Energetick Principles*, of either *Syſtems* reſpectively. Next we have a *Maſs*, of extended ſenſible Matter, if collectively conſidered, or *Syſtems* of *material Bodies*, diverſly figured and ſituated in regard to one another, if ſeparately conſidered: And in both theſe views, they admirably repreſent the Subject or Object of the *Deſire*, which is Analogiſed by *Attraction* or *Gravitation*. And laſtly we have the *Harmonious*, *Comely*, and *Decent* Motions, and Actions of one Body upon another, ariſing from the *Attraction* or *Gravitation's* being impreſs'd on the *Maſs*, and each particular Body; and this too, anſwers wonderfully to the *Third* Principle in the *Univerſitas rerum*. And this *Analogy* deſcends even to particular Bodies, for in theſe we have the Form, the Subject Matter and the *Congruity* between theſe.

Scholium II.

From the whole proceeding Chain of *intellectual Truths*, we may form to our ſelves ſome *faint*, *low*, and *imperfect Image* or Repreſentation of the EVER-BLESSED TRINITY IN UNITY. For ſince, by *Corollary* 1. *Prop.* 14. the *Modes* of natural or created Things, when *Analogically* elevated to their ſimilar Attributes in the *ſupreme Infinite*, in *Him*, are infinite *Realities*. Since, by the *ſame Propoſition*, an intelligent Being is, as to it's ſpiritual Part, an *Emanation* from, an *Image* and *Repreſentation* of, the *ſupreme Infinite*: And ſince alſo, in regard to theſe intelligent compounded Beings, all that is in the *Univerſitas rerum omnium*, may be fully comprehended under theſe Three general

Heads or Principles. The *Deſire*, the *Object* and the *Senſation* ariſing from the *Congruity* or *Incongruity* between the *Faculty* and the *Object*. Since laſtly, this *Analogy* is preſerv'd full and clear, through the *ſpiritual* and *material* Worlds, and each particular Body, that is, through the whole *Syſtem* of Creatures: It is highly probable, ſo conſtant, and univerſal an *Analogy*, can ariſe from nothing, but from it's *Pattern* and *Architype* in the Divine Nature: And without all peradventure, cou'd we fully and clearly carry it up to it's *Source*; we ſhou'd there find the *Origin* and *Source* of this HOLY TERNARY; or of theſe Three eſſential Relations, of the whole, to the whole in the completion of the GODHEAD. Let us therefore try, in ſome poor low manner, to carry up this *Analogy*, as high as poſſibly we can. The firſt thing then that we are to conſider, in the Divine Nature is, the *Deſire*, now this being ſuppoſed, to belong to a *ſupremely infinite intelligent Being*, muſt be an infinitely *Active*, *Ardent*, *Strong*, and *Powerful Thought*. And that, not as created, or *relative Infinitude* expreſſes it, but as the abſolute and *ſupreme Infinitude* elevates this *Deſire*. Now then this ſupremely Infinite *Deſire*, this *Active* and *Ardent Thirſt* after Happineſs, or after a full, plenary, and compleat, Beatifying Object, we ſhall ſuppoſe to repreſent the FATHER, the *Original* and firſt *Principle* in the Divine Nature: Seeing then, there is no conſideration here of any thing but of *God himſelf*, nor is it poſſible for any other Object, but *God himſelf* to ſatisfy, and adequately to fill this *ſupremely infinite Ardor*, *Thirſt*, and *Deſire* of *Happineſs*. Therefore *He-himſelf*, reflected in upon *Himſelf*, viewing and contemplating his *own* infinite Perfections: The *infinite ardent Deſire*, fill'd and ſatisfy'd with his own eſſential Happineſs: The *brightneſs of his Glory*, and the *expreſs Image*, (the eſſential *Idea*,) *of his Subſtance*, reflected in upon *himſelf*: Or *God himſelf*, *reduplicatively* contemplating *Himſelf* (He having nothing elſe poſſible, to be the Object of his *Love*, *Delight*, or *Deſire*) repreſents to us the *Begotten Deity*, the SON, the ſecond Divine *Principle* in the Order of the *Godhead*. Upon this *reflexion*, *contemplation*, and poſſeſſion of *God-himſelf*, in *Himſelf*; there muſt of neceſſity ariſe, a *Joy*, *Happineſs*, *Acquieſcence*, and *Satisfaction* of *God-himſelf* within *Himſelf*, ſo much the more *Perfect*, *Full*, *Extreme* and *Infinite*, as his *Deſire*, *Thirſt*, and *Ardor* after Happineſs, was *Active*, and *Strong*. And this may ſhadow out to us the third and laſt, in Order, of theſe eſſential *Principles*, in this *myſterious Ternary*, to wit, the HOLY

GHOST. And tho' theſe three Relations, of the *Godhead* in it ſelf, in regard to Creatures, and when deriv'd down *Analogically* to natural Things; may appear but *Modifications* of a real Subſiſtence, yet in regard to the *Divine Nature*, and conſidering his *ſupreme Infinitude*, they muſt be *eſſential*, and infinitely *real* and *living Principles*; and in this *Image*, and view of the HOLY AND UNDIVIDED TRINITY, *low* and *poor* as it is; It is impoſſible the SON ſhou'd be without the FATHER, or the FATHER without the SON, or both without the HOLY GHOST. It is impoſſible, the SON ſhou'd not *neceſſarily* and *eternally* be Begotten of the FATHER, or that the HOLY GHOST ſhou'd not *neceſſarily* and *eternally* proceed from both; *He* neceſſarily ariſing from the *Senſation* of the infinite Agreement and *Congruity* of the *Object* with the *Deſire.* And tho' the *Idea Image*, or *Repreſentation*, that *God* makes of *Himſelf* to *Himſelf*, be the ſame *God* in *Eſſence*, ſince it is a moſt perfect, expreſs, and ſubſtantial *Image*, or *Repreſentation* of the whole Divine Subſtance and Nature, and *neceſſarily* has in it, the whole, that is in *God*, and with the ſame infinite Perfections, that is really in the *Godhead:* Being only the *Divinity*, reflected in upon it *ſelf*. Yet there is a difference, between the *Idea*, *Image*, and *Repreſentation*, and the *original Divinity*. For the ſame Perfections which are in the *original* and *contemplating Divinity directly*, are but *indirectly*, and by reflection in the *contemplated* and *Begotten Deity*; and they differ, by the *Relations* of *Begetting*, *Contemplating*, and *Repreſenting*; and being *Begotten*, *Contemplated*, and *Repreſented*: And tho' theſe be only *meer Relations*, and *Modifications*, when transfer'd to natural and created things, yet are they *infinite Realities* in the *Deity*. It is the ſame with the *Senſation*, of *Love*, *Joy*, *Acquieſcence*, and *Happineſs*, that ariſes in the *Divine Nature*, from *contemplating* and *poſſeſſing Himſelf* and his own infinite Perfections, within *Himſelf*. And theſe *three Relations*, of *Contemplating*, being *Contemplated*, and of *Acquieſcence*, ariſing from them: Which in a natural view, wou'd only be *Modifications*; Yet in the *Divine Nature*, are infinite *Realities* and *eſſential and living Principles*: And may ſerve as a faint and imperfect *Image* of THIS ADORABLE AND UNSEARCHABLE MYSTERY. Now tho' theſe views, and Repreſentations, of this INEFFABLE AND INCOMPREHENSIBLE MYSTERY, ariſe *naturally* and *neceſſarily* from the *Analogy* of Things, ſufficiently eſtabliſhed in the *preceding Propoſitions*; and without all doubt, have ſome *real Truth* in them; ſince it is certain, theſe

Relations and *Modifications* of Subſiſtence, are really in *intelligent Beings*, in the *material Syſtem* of Things, and in *particular Bodies*: And cou'd have no other *Riſe* and *Source*, but from their *Pattern* and *Architype* in the *Divine Nature.* Yet when apply'd to the *ſupreme Infinite*, theſe relations and diſtinctions, muſt be expreſs'd in Words, that have a quite different Senſe affix'd to them, by common uſe, from what they ſhou'd here *import*: And ſince the *Attributes* and *Relations* of the *ſupreme Infinite*, muſt be *Incomprehenſible* to *finite Creatures*, eſpecially to *Creatures*, converſant only about low, groſs, and material *Images*; all I wou'd be underſtood to conclude, from this *Analogy*, thus raiſed to the *ſupreme Infinite* is, that *Reaſon* may form an *Analogical* imperfect *Image* (and that's all it can do) of this INCONCEIVABLE MYSTERY, which may in ſome meaſure help thoſe, (who have not attain'd to a more perfect Guide or higher Lights) to believe the poſitive Relations of his own Nature, by *God himſelf*, tho' they be not able, perfectly to comprehend or expreſs them. And if this poor Repreſentation, of ſo PROFOUND A MYSTERY, ſo *Certainly*, and FULLY reveal'd in *Holy Writ*, can by the *Divine Bleſſing*, any wiſe Contribute, to *ſettle* and *quiet* ſober and honeſt Minds, I ſhall have my full

Intention. Nothing leſs than *Omnipotence*, and *Omniſcience*, being ſufficient to deal with thoſe, who are otherwiſe diſpoſed.

Propoſition XVIII.

There muſt of neceſſity be ſome *Principle* of *Action* in intelligent Beings, *Analagous* to that of *Attraction* in the material *Syſtem*, and that is, the *Principle of Reunion* with the *ſupreme Infinite*, by him originally impreſs'd on their *ſupreme Spirits*.

Demonſtrat. That there muſt be ſome Principle of *Action* impreſs'd on intelligent Beings, *Analogous* to that of *Attraction* in the material *Syſtem*, is evident from the *Analogy of Things*, the Conſiſtency of the Works of the *ſupreme Infinite* with themſelves, the *Uniformity* conſpicious in all the Creatures, and that the material are but *Images* and *Repreſentations* according to their reſpective Natures, of the *ſupreme Infinite*, as well as of the intelligent *Syſtem* of Beings. There muſt therefore ſome *great Principle* of Uniformity, run thro' both *Syſtems*, that is, the whole Creation. Now that *Attraction*, or ſomething *Analogous* thereto, is the great Principle of *Activity* in the material *Syſtem*, has been ſufficiently Demonſtrated in the former Part of this Treatiſe. There muſt of neceſſity therefore, be ſome *great Princi-*

ple Analogous to this, in the *Syſtem* of intelligent Beings. And that this can be nothing, but that great *Principle of Reunion*, with the Author of their Being, originally impreſs'd on every intelligent Creature: Is evident from hence, to wit, that the *ſupreme infinite Being*, infinitely powerful, and perfect, muſt neceſſarily ſubject, draw, and unite all intelligent Beings to Himſelf, to make them as happy, as their reſpective Natures can admit. That Himſelf is the *Sole Object* of their Happineſs can not be doubted, there may be collateral and acceſſory Objects of their Happineſs, but even theſe muſt flow from him: But that he is the ſupreme Object, and the ſingle one that can adequatly ſatisfy them, has been ſhewn before: That therefore, to bring them to this Happineſs, he muſt impreſs upon, or derive to them, a *Principle of Reunion* with himſelf, is plain, becauſe this is the ſingle mean, to bring them to this end; for the known Law of Nature, obtains even here, and every where, to wit, that *Action and Reaction is Mutual*, ſo that if the *ſupreme Infinite* muſt draw them to him in Order to make them happy, they muſt have a Principle of being drawn towards him. That it muſt be a *radical* and *eſſential* Principle, is evident alſo, becauſe this happineſs is the very end of their Creation, it being impoſſible infinite Perfection ſhou'd make intelligent Beings, for any leſs or any other *End.* Wherefore the *ſupreme Infinite*, cou'd not make intelligent Creatures, without *implanting* in their Natures, a *moſt ardent Deſire*, an *eſſential* Principle, interwoven in the Subſtance of the ſpiritual Natures, of being re-united with Himſelf, in order to make them as happy, as their relative Natures will admit of. Beſides, intelligent Beings (as to their ſpiritual part) are Images of the *ſupreme Infinite* by *Prop.* 15. In him there is an *infinite Deſire*, and *Ardor* of poſſeſſing and enjoying Himſelf, and his own infinite Perfections, in order to render him happy, he himſelf is the *ſole Object* of his own, and of the felicity of all his Creatures. There muſt therefore be an Image of this his infinite Deſire after Happineſs in all his intelligent Creatures; and this Image, can be nothing but this *Principle of Reunion*, ſince nothing but this can unite them with him, to make them happy. Laſtly, an intelligent Being, coming out of the Hands of *infinite Perfection*, with an Averſion, or even Indifferency, to be re-united with it's *Author*, the Source of it's utmoſt Felicity, is ſuch a ſhock, and deformity in the beautiful *Analogy of Things*, ſuch a breach, and gape in the *harmonious Uniformity*, obſervable in all the Works of the Almighty, and that too, in the nobleſt and higheſt part of his Works; as is not conſiſtent with finite Wiſdom and Perfection, much leſs with the *ſupremely infinite* Wiſdom of the ALL-PERFECT. Wherefore, *&c.* q. e. d.

Corollary I.

Hence we may diſcover the Source, of *natural Conſcience*, and of all thoſe Motions and Convulſions, that are raiſed in the Breaſts of compounded intelligent Beings, upon the *Commiſſion* or *Omiſſion* of certain Actions: Of that *Comfort*, *Joy*, and *Support*, in ſome; and of that *Dejection*, *Dread*, and *Terror* on the Minds of others; where no natural Cauſes can be aſſigned. Hence the *noble* and *ſublime Diſcoveries* of the *antient Heathen Philoſophers*, in the Principles of moral Virtues, without the aſſiſtance of Revelation. Hence it is, that *Scelerats*, can by no Arts, nor any Amuſements how violent ſoever, ſtifle the Cries of a wounded Conſcience; and hence alſo, it is, that honeſt and upright Minds, are ſometimes ſwallow'd up, by a Tranquility and Peace that ſurpaſſes natural Underſtanding. That this *Principle of Reunion*, is defaced, buried, and in ſome meaſure as it were, obliterated, by contrary *Attractions*, by *Senſuality*, and the violent Amuſements of Licentiouſneſs in compounded intelligent Beings, is no more an Argument againſt it's *eſſentially* belonging to intelligent Beings, than the *Ideotiſm* of ſome is an Argument againſt the Principle of Reaſon in humane Nature. But

Corollary II.

From this *Principle's* being ſo *radically* implanted, in all the Individuals of intelligent Beings, and from the ſo very few Inſtances and Remains of it, conſpicuous in the humane Race; we may gather the infinite and univerſal Degeneracy, and Corruption, of this ſet of intelligent Beings, from their *Primitive* and *Original* Inſtitution. This Principle was moſt certainly implanted in their Creation, in the very *Fund*, and Subſtance of their Natures, and yet there remains but few Footſteps, and Inſtances of it's *Being*, or *Effects*. There are indeed (as in the Greater World) ſome *legible Characters*, *ſtrong Out-lines*, and *prominent Lineaments*, of it's original Beauty, ſome *magnificent Ruines*, which ſhow what it had been enough to Demonſtrate the *original Impreſſion*, Beauty, and real Being, of ſuch a *Principle*, in all the Individuals of this Race, as is evident from the *Pangs* and *Tortures* of *natural Conſcience*, when it is counter-acted. But the little effect it has, from what it was deſign'd to have, is an evident Demonſtration of the deep and univerſal Corruption of this *Set* of intelligent Beings.

Corollary III.

Hence we may further diſcover, the Force, Truth, and Univerſality of this wonderful *Analogy of Things*, whatever we diſcover of the Works of Nature, is from this Source, and whenever we get the leaſt *Glympſe* into the manner of the Divine Operating, we diſcover freſh Inſtances of this *Analogy*. This *Principle of Reunion* in intelligent Beings, wonderfully *Analogiſes* with that of *Attraction* in the material World: As to the *ſupreme Infinite* it may be very properly called his *Attraction* of them, and as to them, their *Central Tendency* or *Gravitation* (ſo to ſpeak) toward him; and this *Principle of Reunion*, if attended to, duly Cultivated, and Expanded, wou'd as certainly bring about, the Temporal and Eternal Happineſs of all intelligent Beings, in the *ſpiritual World*; as that of *Attraction*, brings about the Comely and *Harmonious* Motions, of the *great Bodies* of the *material World*. This *Principle of Reunion* is the *original* Source and *Spring* of the *Deſire*, afore Demonſtrated, to be the

Cardinal Faculty of the ſpiritual Part of intelligent Beings. The *Principle of Reunion*, is the *Root* and Foundation of the *Deſire*, in regard to it's firſt Cauſe and original Impreſſion, by the *ſupreme Infinite.* This *Principle of Reunion*, as it is conſidered, as an infinitely *active*, *quick*, and *ſenſible* Faculty, in the ſpiritual part of compounded intelligent Beings, is the *Deſire of Happineſs*; as it is conſidered as a *Theological* Virtue, it is *Charity*; and as it is conſidered as a *Rule* of Action, it is *natural Conſcience.* But the *Principle of Reunion*, in it's whole extent, as it was originally impreſs'd upon, and quite interwoven with the intimate *Fund*, and Subſtance, of the ſpiritual part of compounded intelligent Beings, is the *Source*, *Origin*, and *Root* of all theſe.

Corollary IV.

Hence, the true and genuine Nature, of *Moral Good* and *Evil*, and of all the Moral Virtues, and *Social* Duties of Life; as from their genuine Fountain and Source, is to be derived. Whatever retards, or oppoſes this R*eunion*, in intelligent Beings, is to them *Moral Evil*; whatever promotes, or advances this R*eunion*, is to them *Moral Good.* Beſides, this *Principle of* Reunion, duly Cultivated, regularly Unfolded, and carefully Attended to, muſt neceſſarily produce and perfect in the Soul *univerſal Charity*; that is, the Love of the ſupreme Being, and of all his Images in a due Subordination; and thereby inſtruct, and beget in the Soul, all the *Moral* Virtues, and *Social* Duties of Life. All theſe, being *virtually* and neceſſarily included in *Charity*. But to explain this matter (which is of the utmoſt conſequence towards a right Apprehenſion of *ſolid Religion*) a little further, I ſay

Propoſition XIX.

Charity, or the Love of the *ſupreme Being*, and of all his *Images*, in a proper Subordination, according to their *Rank* in the *Scale* of Subſiſtences, is the neceſſary effect of this *Principle of Reunion*, when fully expanded, and ſet at freedom.

Demonſtrat. By *Corollary* 4. *Prop.* 17. nothing but the *ſupreme* and *abſolute Infinite*, can adequatly fill and ſuperabundantly ſatisfy, the *infinite Deſires* of intelligent Beings, the *Deſire* in intelligent Being is their *Love*, for no intelligent Being can deſire any in order to make it Happy, but what it *loves*; or can *love* any thing, but what it *deſires* to enjoy, (*Indifference* being the middle State, and *Averſion* the equal

Oppoſite, both to *Love* and *Deſire.*) So that an infinite *Deſire* of the *ſupreme and abſolute Infinite*, is an *ardent Love* of that *Being*. But the *Principle of Reunion*, expanded, ſet at freedom, and arriv'd at it's *ultimate End* and *Center*, is intirely the ſame with the *infinite Deſire* in intelligent Creatures, poſſeſs'd of it's ſole and proper Object, the *ſupreme and abſolute Infinite*. Conſequently the *Principle of Reunion*, expanded, and ſet at freedom, in order to arrive at this *ultimate End* and *Center*, muſt *neceſſarily* beget, in the Spirits of intelligent Creatures, this *infinite Deſire* of the ſole and proper Object; that is, an *infinite Love* of the *ſupreme Being*: And by neceſſary conſequence, a *Love* of all his *Images* in proportion to their *reſemblance* of Him; that is, the *Principle of Reunion* when expanded, and ſet at freedom, muſt neceſſarily beget, in the Spirits of intelligent Beings, a *Love* of the *ſupreme Being*, and of all his *Images* in a proper Subordination, according to their R*ank* in the *Scale* of Subſiſtences, that is *Charity*. q. e. d.

Corollary I.

Hence, *Charity*, or the *Love* of the *ſupreme Being*, and of all his *Images* in a proper Subordination, in it's true and genuine Nature, is not founded on *Intereſt*, or the *views* of *Rewards* and *Puniſhments*; but altogether, on the *abſtracted Perfections* of it's Object, the *ſupreme Infinite*. *Charity* in it's Origin, and as it ought to be, according to the true *Analogy* of Things, is a *Phyſical*, and neceſſary conſequence of the *Principle of* Reunion: It flows naturally from an *implanted* Faculty, and has for it's Object the *ſupreme Infinite*, in his own *independent* and *eſſential* Nature, as he is *abſolutely* Good, and Perfect, without any *collateral* Views or Regards. *Charity* is in a higher degree, and in a more noble Creature (one, to wit, endowed with freedom and liberty of Acting,) what *Motion* proceeding from the Principle of *Gravitation*, is in *Brute-matter*, or what the *Tendency* of the *Planets* is, towards the *Sun*, *viz.* a natural Conſequence, of an implanted Principle. This is ſo clear and ſo certain, in true *Phyloſophy*, that it is matter of Aſtoniſhment to me, how it came once to be doubted, much leſs diſputed. *Henry Moor's* Argument on this Head, is as cogent and juſt, as any Demonſtration in *Euclid* or *Appollonius*! “*As the Object of the Intellect* “*(ſays he) is that which is ſimply true,* “*and is aſſented to as ſuch, and not as true* “*to this particular Intellect which contem-* “*plates it, ſo there is an Object that is*

“ *ſimply Good and Lovely, and to be Lo-*
“ *ved as ſuch, without regard to the Party*
“ *that thus loves it.* And in another place, he uſes the familiar Illuſtration of *Ginger-Bread* and *Mathematicks*, wherein he grants the former, may be a Spur to the latter, 'till Age and good Senſe, with the Knowledge of the intrinſic Beauty and Worth of the latter, makes the *Student* in Love with the *Study* it ſelf, without any conſideration of the *Childiſh Bait.* As in natural Love, Perſons become often enamoured of *outward Beauty*, without any particular Knowledge of it's Poſſeſſor, or it's *attainableneſs* by them; ſo without all peradventure, *infinite Perfection* for it's own intrinſic *Pulchritude*, muſt be the proper Object of *Divine Charity*, without any particular regard to the Party loving it. Not that *Intereſt*, or a *View to* Rewards and Puniſhments, is not often the only Motive of *Divine Love*: And always is a very proper and *laudable* one, when *infinite Perfection* is the Object. And in reality, it is as high, as moſt of the *lapſed* Race *of Adam*, in their degenerate State can riſe to. But as things are in their *original Natures*, were in their *Integral*, and muſt be in their *reintegrated* State. *Infinite* Beauty, or Perfection, without any regard to *Self-intereſt*, or any view to *Rewards or Puniſhments*, is, was, and muſt

muſt be, the proper and ſole Object of pure and perfect *Divine Love*, or *Charity*.

Corollary II.

Hence the *Service*, *Worſhip*, and *Homage*, we owe to the *ſupreme* Being, is founded intirely upon his own *original Excellencies*, and Perfections, and not on his *Rewards* and *Puniſhments*; there neither ever was, nor ever cou'd be, any room for *Contracts*, or *Pactions*, between the *ſupreme* Being, and his intelligent Creatures, in the original Conſtitution of Things. *He made all Things by the Word of his Power, and for his Pleaſure they are and were created. Infinite Perfection* is to be *Lov'd*, *Admir'd*, *Ador'd*, and *Serv'd*, for being infinitely perfect *Antecedently*, and without any regard to Creatures: And when Creatures are brought into Exiſtence, this *primary* Reaſon of *Love*, and *Adoration*, ſubſiſts, and in order of Nature and Dignity, is *prior* and preferable to all other Reaſons. *Creation* adds nothing eſſential to *infinite Perfection*, but a *Circumſtance* only, which too, intirely evaniſhes when brought into Compariſon, with the original Beauty of the *abſolute Infinite*. All his Creatures that act naturally, correſpond, and are faithful, to the greateſt exactneſs, to his *original Impreſſions*, and his appointed and deſign'd Ends on them. The *Celeſtial Orbs*, the *Sun, Planets, Comets*, and *fix'd Stars*, thoſe huge unweildy Maſſes of Matter, revolve in regular *Periods* and conſtant Order, by their impreſs'd Power of *Gravitation* and *Primitive Frame*. The *Vegetable Tribes* are faithful to his appointed Seaſons. The *Brute Animals*, ſacredly obey their *inbred Inſtincts*. Only his compounded intelligent Creatures, if they at all obey, do it for their own, not his ſake, that is, they themſelves are their own *ultimate End*, contrary to what was *Demonſtrated, Corollary* 4. *Prop.* 17. It is true in the Nature of Things, it's abſolutely impoſſible, to ſeparate the *Duty* and *Felicity* of intelligent Creatures, their *Happineſs* conſiſting, in their being in the *Order* of their Nature, that is, of GOD *it's Author*, and their only *Duty* being faithfully to obey this *Order*. Yet theſe Two may be conſidered apart, and *Mentally* abſtracted the one from the other: And the laſt muſt be *Anterior* to, and in the Order of Things, muſt precede the former: So that when we invert this *Order*, and bring in our *Happineſs*, as the ſole *Motive*, or the preferable *Motive* to our *Duty*, we become guilty of the moſt *groſs and blackeſt Idolatry*: For he who loves and worſhips the *ſupreme Being*, only becauſe his own *Happineſs* is thereby brought about, makes Himſelf and his own Happineſs, his *ultimate End*, and ſo places himſelf in the R*ank* and *Order*, that belongs to GOD only, and himſelf becomes his own *Idol.* He only can be ſaid truly to *Love* GOD, with a *Love* undivided, and worthy of him, who having *loved him*, as far as R*ewards and Puniſhments* will carry him, goes on ſtill further to *love him*, looſes all views of theſe *mercenary Motives*, and ſeeks for no Fuel to feed the *celeſtial* Flame, but the *unexhauſtible Pulchritude*, and Perfections of the *beloved Object.*

P*ropoſition* XX.

Charity, or the pure and diſintereſted *Love* of GOD and of all his *Images* in a proper Subordination is the *end of the Law*, the *Accompliſhment* of all the *Graces*, and the conſummate Perfection of *Chriſtianity.*

Demonſtrat. *On theſe Two*, to wit, *the Love of* GOD and *our Neighbour hang both the Law and the Prophets*, ſays the ADORABLE AUTHOR OF CHRISTIANITY, and the *Apoſtle* ſays, *the end of the Law is Charity*, if the *ſupreme Being* is the *ultimate* Object of the Felicity of all intelligent Creatures, and *Charity* the mean to attain this end, as is evident from the *preceding Propoſition*, then is *Charity* the conſummate *Perfection of Chriſtianity.* The whole of *Chriſtianity* is nothing but Rules for attaining this *Love*, or Meaſures whereby to remove the Impediments that hinder this *Principle of Reunion* (the ſource of *Charity*) from Operating, or means to deſtroy the contrary *Attractions* which diſturb the natural Operation of this *Principle of Reunion*; which wou'd of it ſelf, if not Stifled, Oppoſed, and Counteracted, neceſſarily beget this *Divine Charity*, whereby the Soul wou'd inſtantly be united with it's *Center*, and *ultimate End* the *ſupreme and abſolute Infinite*. q. e. d.

Scholium.

To this Doctrine of *pure Love*, there are made but Two Objections which have any Weight or Force in them. The Firſt is, that the *Motives* for *Love and Obedience*, urged by *Moſes* and the *Prophets*, CHRIST and his *Apoſtles*, are founded on *Rewards and Puniſhments*, and that therefore without *Blaſphemy*, we are not to offer at, or pretend to, more high and ſublime *Motives* or Principles, than the *Friend of* GOD, and the SON OF GOD, (the Standard in their ſeveral Diſpenſations, of Purity and Perfection) thought fit to preſs or propoſe. The plain and genuine Anſwer to this Objection is, that the *Author of our Being*, *who loves all his Creatures better* *than they can love themſelves*, uſes all *Motives* that are *Honeſt*, *Laudable*, and *Juſt*, to gain them; he knows perfectly the *Frame* and *original Complexion* of all his Creatures, and that in their *lapſed State* they muſt aſcend to Perfection by Steps and Degrees; and conſequently that ſome are to be wrought upon by one *Motive*, others by another, and that generally the firſt Steps are mounted by the force *of the Terrors of the Lord*, before *the Love of* GOD *is ſhed in their Hearts*. There are *Babes in* CHRIST, as well as *grown and perfect Men*, and their Food (or Motives to Charity) muſt be as their Years and Strength are: But our SAVIOUR *tells us*, *we muſt love the* LORD *our* GOD *with all our Heart*, *with all our Soul*, *with all our Strength*, *and with all our Mind*, and if ſo, we ſhall have very little *Love* left behind, for *our ſelves*. And *his beloved Diſciple* tells us, *that perfect Love caſteth out Fear*, and conſequently *Hope*, that is, *Rewards and Puniſhments*: Which are true, good, and *ſalutary* Motives, tho' not the beſt. The ſecond Objection is from the impoſſibility of *Loving* or begetting *Love* without a Regard to *Rewards or Puniſhments*. But this Objection, ariſes from Ignorance of the true Nature of this Affection of the Soul. *Love* is the Complexion of the *Will or Deſires*, as was ſhown *Prop.* 15. it belongs to the *unin-*

uninlighten'd Faculty of the Mind, the *Will*, and not to the enlighten'd Faculty, as the *Underſtanding* is, and ſo naturally, and of it ſelf has no real reſpect to *Rewards or Puniſhments*, which are Motives offer'd by the Underſtanding; we *Love* becauſe we will *Love*, without *Reaſoning*, or becauſe the Object of our *Love* is amiable, and not becauſe it will hurt or heal us. *Love* is Blind, and belongs intirely to the *Will*, and not to the *Intellect*. But paſſing this, as perhaps too *Metaphyſical*, I anſwer, *Secondly*, as we may for one ſingle *Inſtant*, and for one ſingle *Act*, abſtract from a Reward, forget it, or counteract it, (which no Body who knows the preſcindent Faculties of the Soul, and that *Love* and Rewards are eſſentially united in their own Natures, can deny) ſo we may thus *Abſtract* again, and again, and ſo *in Infinitum* and thus beget a *Habit* for what may once be done, may for any impoſſibility in the Nature of the thing, be done *for ever*: This is *Demonſtration*. But I proceed,

Propoſition XXI.

In all intelligent Beings, there muſt be *Faculties* fitted for all the ſeveral *Ranks* of Objects, in the *Univerſitas rerum*; that is, ſince there are evidently Three *Ranks* of

Objects, in the *Univerſitas rerum*; to wit, the *material Syſtem* of Things, the *ſpiritual World* of created Spirits, and the *ſupreme and abſolute Infinite.* Intelligent Beings muſt neceſſarily be fitted, with *Faculties* ſuited to theſe Three generical Ranks of Objects.

Demonſtrat. This is evident from the ſeveral different *Mediums*, which all infer the ſame Concluſion. 1. Intelligent Beings are *Images* of the *ſupreme Infinite*, who alone perfectly comprehends and knows himſelf and all his Creatures, that is, all theſe Three *generical Objects*, in the *Univerſitas rerum.* He has different Senſations and Perceptions (as far as *Diverſity* can be conſiſtent with his infinite *Simplicity*) ariſing in himſelf from all theſe Three different Objects, and conſequently Faculties fitted for them: Therefore intelligent Creatures, his *Images* the *Repreſentations* of all his communicable Perfections, muſt of neceſſity, have *Analogous* Faculties, fitted for all theſe Three different Objects. 2. There are R*elations*, incumbent upon all intelligent Beings, towards each other, and towards the *ſupreme Infinite.* Such as *Love*, and *Benevolence*, therefore intelligent Beings muſt be endow'd with Faculties fitted for receiving the Impreſſions, and to perceive the effects of theſe R*elations*, elſe they wou'd be in vain: And theſe are Two of the different R*anks* of

Objects; and no body queſtions intelligent Beings, being fitted with Faculties for the Third; to wit, the *material Syſtem* of Things. 3. As to the *ſpiritual World*, including the *ſupreme* and *abſolute Infinite*, as it's *Head.* The *Principle of* Reunion, whoſe neceſſity in intelligent Beings, I have now Demonſtrated, makes it abſolutely neceſſary, they ſhou'd be provided with *Faculties* fit for *Communication* and *Union* with the *ſupreme Infinite*; elſe, they were not ſuſceptible of that Happineſs which was the *ſole End* of their Being. 4. That which is the *Apodeictick Demonſtration*, of the Truth of this *Propoſition*, and at the ſame time proves the Diverſity of theſe ſeveral Faculties, to be as real as that of the Objects is, is the manner after which compounded intelligent Beings, are provided with *Faculties* for the *material Syſtem* of Things. Material Things are preſented to them only through their Senſes; they have a real and material *influx* on theſe; elſe they are not really perceiv'd; and all real Knowledge of material Things, is convey'd into the Underſtanding, through theſe *Senſes.* Wherefore it is evident, compounded intelligent Beings, are endowed with a Faculty of perceiving or receiving material Things, thro' their Senſes, which is called *Perception.* Next they have a Faculty of painting theſe Perceptions or their Images when the Objects are abſent, and this is called Imagination, and *laſtly*, a Faculty of *Combining* and comparing the real Perceptions of theſe material Things or their *Images*, and this Faculty is called *Reaſon*. And all theſe *Three* diſtinct Operations belong to the *rational Soul*, in order to fit it for Communication with the material World. Now by the *Analogy* of Things, ſuch like, and *ſimilar* Faculties, muſt of neceſſity belong to the *ſpiritual* part of compounded intelligent Beings, to fit them for a communication with the Two remaining *Ranks* of Objects; to wit, a ſpiritual *Perception* and *ſpiritual Senſes*, *Imagination* and *Underſtanding*, for the *ſpiritual* World of intelligent Beings, and *Divine Senſes*, *Perception*, *Imagination* and *Underſtanding*, for communicating with the *ſupreme Infinite*. For this *Analogy* will perpetually hold good and true, from the *Simplicity* and *Unity* of the *Divine Nature*, to wit, ſuch as the Faculties are by which we *communicate* with the *material* World, ſuch *Analogically* and with proper Limitations, are thoſe by which we *Communicate* with the *World* of Spirits, and the *ſupreme Infinite*. And as we ſee compounded intelligent Beings, have bodily *Senſes* which ſolely belong to the *material* World, ſo in the *Analogy* of Things, they muſt have Faculties different and diſtinct in themſelves peculiarly fitted and appropriated to the other Objects in the *Univerſitas rerum.* Wherefore, *&c.* q. e. d.

Corollary I.

Hence, we may conceive the Reaſon why in *Holy Writ*, the whole Man is diſtinguiſhed into *Body*, *Soul*, and *Spirit*; whence comes the diſtinction, of the *natural*, and *ſpiritual* or *inward Man*: Between the *Law of the Members*, and the *Law of the Mind.* Theſe Diſtinctions, and Diviſions, I ſay, are eaſily conceiv'd from the foregoing *Propoſition.* For the Body and rational Soul belong to this *material Syſtem* of Things, and are fitted with Faculties for *Communicating* with it, and is called the outward Man, and the following it's practical Dictates in Rebellion againſt, and in Oppoſition to, the Dictates of the *Spirit*, the *inward* Man, the eſſential *Principle of Reunion*, the *Law of the Mind*, which is fitted only for *Communicating* with the *ſupreme Infinite*: I ſay, the following the practical Dictates of the firſt, in oppoſition to the *Dictates* of the latter, is called in the Language of the *Spirit*, the following the *Law of the Members.*

Corol-

Corollary II.

As there are *Three* different Principles, Orders, or *Predicaments* of Being; to wit, GOD the *Creator of all Things*, *created Spirits*, and *material Bodies:* So there are *Analogically* in compounded intelligent Beings, *Three* different and diſtinct Principles, adapted and appropriated, for Communicating with, and enjoying theſe reſpective Objects: Whereof every one is endowed with proper *Senſes*, *Powers*, and *Faculties*, different and diſtinct from each other. That is, as the *material Syſtem* of Things, is the proper Object of the Senſes, and rational Soul; and as this Principle is fitted with outward *Senſes*, *Perception*, *Imagination*, *Underſtanding*, and *Will*; So the Principle, whereby they are fitted, to Communicate with the created ſpiritual World, is endowed with inward *Senſes*, *Imagination*, *Underſtanding*, and *Will*; and the *ſupreme Spirit*, or Third Principle, whereby they are fitted to Communicate with the ſupreme uncreated Infinite, is endowed with *inmoſt* (ſo to ſpeak) *Senſes*, *Imagination*, *Underſtanding*, and *Will*; and all theſe in their *primitive* and *original* Conſtitution, in Subordination, *Harmony*, and Agreement, without Contrariety or Confuſion one with another. This *Corollary* is as certain as the *Analogy* of Things is.

Corollary III.

Hence, we may deduce the true and genuine Nature, and Extent, of the *Degeneracy*, *Corruption*, and *Fall*, of the Humane Race of intelligent Creatures; which conſiſts, in the *Confuſion*, *Diſcord*, *Rebellion*, and *Contrariety*, of theſe different and diſtinct Principles one with, and againſt another; in throwing of that *due Subordination*, *Subjection*, and proper *Rank*, and Order, that was originally eſtabliſhed among theſe Faculties; according to the Dignity of theſe different Objects; the Order of Nature, and the *Analogy* of Things, and following the practical *Dictates*, and Concluſions deduced from theſe rebellious Faculties. That is, when in this *Anarchical* and rebellious State, of humane Nature. The Faculties belonging to the material World, preſumes to Judge of, and determine the Nature of the Subjects, belonging to the *ſupreme* Spirit; takes the Government and Adminiſtration of the whole Man, which properly belongs, in the Order of Nature, to this Third Principle, leads the other Principles, as *Slaves* and *Captives*, and forces them to comply with the practical *Dictates* they preſcribe, and deduce in their uſurp'd Superiority; and under this complyance, begetting and producing phyſical and durable Effects, the whole Order of Nature, and the material *Syſtem* of Things, ſo far as theſe *phyſical* and durable Effects reach, becomes Diſtorted, Inverted, and Corrupted.

Propoſition XXII.

The *rational Soul*, is not that Faculty in compounded intelligent Beings, which in the Order of Nature, and the *Analogy* of Things, is appropriated for the ſpiritual World (including the ſupreme Infinite as it's Head.)

Demonſtrat. Tho' this be a neceſſary *Corollary* from the preceeding *Propoſition*, yet ſince it is of great conſequence to true Divine Knowledge, to have it's Truth eſtabliſhed beyond all poſſibility of *Cavil*. I ſhall here ſuggeſt ſome other *Mediums*, or ſet thoſe already ſuggeſted in another Limit, from whence the ſame *Concluſion* may be deduced. And 1. this is evident from the Nature of this *Faculty*, and the manner of it's Operating. *Reaſoning* is the comparing, or the conſidering the *Congruity* or *Incongruity* of the Perceptions, ſuggeſted by the Senſes, or of the *Ideas* lodged in the Memory, or Painted on the Imagination, to one another; and *Reaſon* is the Faculty whereby this is perform'd. Now the *Senſes* ſend in only, the *Influxes* of material Things, and the *Imagination* and *Memory* preſent only their Pictures or *Images*, when the Objects themſelves are abſent; and here is all the *rational Soul* can do. But nothing of theſe belong to the *ſupreme* and *increated Infinite*, nor the *ſpiritual World*. 2. It is acknowledged by all, and every one's Experience demonſtrates it to Him, that the *rational Soul* is fitted for *Communicating* with the *material World*. Now ſince Body and Spirit are preciſe and proper Oppoſites, it wou'd be as *Diſſonant* and *Incongruous*, in the *Analogy* of Things, that the ſame Faculty ſhou'd be the Principle of Communication with theſe two Objects, ſo widely diſtant, as that the *Eye* ſhou'd both *Hear* and *See*. It is true it may be ſaid, that the *rational Soul* might have been originally endowed with ſuch *Energy* and Capacity, as to be fitted for *Communicating* with *both Worlds*; but this is meerly *gratis Dictum*, and perfectly contrary to the *Analogy* of Things. It being impoſſible, to bring an Inſtance of Nature, where things ſo widely diſtant, and preciſely oppoſite are receiv'd by *one and the ſame* Faculty; we ſee in the *Body*, or loweſt part of the humane Compoſition that it is inſtructed, with *Organs* fitted for all the poſſible ways, material Things can act upon it. And they are not near ſo widely diſtant and different in their manner of Operating, as Bodies and Spirits in their Natures are. 3. There is a Two-fold Knowledge of material Things, one *Real*, when the thing it ſelf, and the *real* Action and Impreſſion thereof, on our Senſes is perceiv'd. The other *Ideal*, when the *Image* or *Idea* of a thing abſent in it ſelf, is repreſented to, and conſidered on the *Imagination.* For Inſtance, the *Heat*, *Light*, and *cheerful Influences*, of the *Sun*, ſhining on us, are widely different, from the view and conſideration of it's *Image*, or *Idea*, on our Fancy. In the *Analogy* of Things, and according to the conſtant Order of *Nature*; ſuch muſt our Knowledge of *ſpiritual* Objects be, to wit, the one *real*, when the Objects make a real Impreſſion upon the *appropriated* Faculty; the other *Ideal*, when we frame a Notion, of it's abſent Subſtance and Qualities. Now it is very plain, the *rational Soul*, is not fitted for this firſt kind of Knowledge or Perception, of *ſpiritual* Objects; ſince a great many *Philoſophical* and *Learned* Men, who have exerciſed this Faculty in it's greateſt Strength and *Vigor*, have deny'd the Exiſtence of ſuch Objects. 4. Laſtly, That moſt certain and ſelf evident *Metaphyſical Axiom*, to wit, *that nothing can be in the Underſtanding, that* *was not firſt in the Senſes*; is a certain *Demonſtration*, that the *rational Soul*, is not the Faculty in intelligent Beings, *appropriated* to the *ſpiritual* World; for every Body allows, that *ſpiritual* Beings, *as ſuch*, can never be convey'd, through the bodily Senſes, to the Underſtanding. And therefore we muſt either be intirely depriv'd of Faculties, for communicating with *ſpiritual* Beings, (that is we muſt be depriv'd, of the only means of our *ſupreme Felicity*, and for attaining the end, for which alone we were created, to wit, communicating with the *ſupreme and abſolute infinite Spirit.*) Or elſe, we muſt be endow'd with Faculties diſtinct from the *rational Soul*, for that purpoſe. Upon all which Accounts it is evident beyond the moſt remote poſſibility of Doubt, that the *rational Soul* is not that Faculty in compounded intelligent Beings, which in the Order of Nature, and the *Analogy of Things*, is *appropriated* for the *ſpiritual* World: But that they are endow'd with a *rational Soul*, and bodily Senſe, to communicate with the *material* World, and with a *Spirit* and *Divine Senſes*, to communicate with the *ſupreme Infinite*. So that the mentioned *Metaphyſical Axiom*, continues juſt and true, as it ſhou'd according to the *Analogy of Things*: That as *material* things, are convey'd to the *rational Soul*, through the *bodily Senſes*, ſo *ſpiritual*

ſpiritual Things (thoſe that relate to *ſupreme Infinite*) are convey'd through the *Divine Senſes*, to the *Spirit*. q. e. d.

Corollary I.

Hence, in the *Analogy of Things*, as the *Light* of the *Sun* (that Noble and Glorious *Repreſentation*, *Image*, and *Vicegerent* of the *ſupreme Infinite*, in the *material* World) is the *Medium*, through which *material* Things are ſeen and perceiv'd in our *Syſtem*, ſo the *eſſential Light* of the *ſupreme Infinite* himſelf, is the ſole *Medium*, by and through which, his Nature and infinite Perfections are to be underſtood, and comprehended. And therefore as certainly, as the *Sun* ſends forth his Light on the whole *material* World without Bounds or Limits, on *the Juſt and on the Unjuſt*; ſo certainly, the *Sun of Righteouſneſs*, the *Pattern* and *Architype* of our *material* Sun, ſends forth his enlightning and enlivening Beams on all the *Syſtem* of created intelligent Beings, and is, *that Light which enlightens every Man that cometh into the World*.

Corollary II.

Hence it is evident, that he who wou'd Judge, Determine, and Purſue the practical

Concluſions of theſe Determinations, about the Nature and Properties of *Spiritual* and *Divine Things*, by his *Reaſon*, wou'd act as incongruouſly, and contrary to the *Analogy of Nature*, as he who wou'd taſte Colours (as ſuch) and look into Sounds. The higheſt that this *Faculty* can juſtly and congruouſly pretend to in theſe Matters, is from the known, certain, and experienced Nature, and Properties of *material* Things, (to which the *rational Faculty* is in ſome meaſure adequate) by a proper *Analogy*: And from the *Viſible's* being low *Images* of the *Inviſible*, and *Spiritual*; to frame *Similar*, but imperfect *Likeneſſes*, and Repreſentations, of theſe ſuperior Objects; their Natures, and Properties, as we have endeavoured to do, in the preceeding *Propoſitions*, and this really, and in fact is all that *Reaſon* can do in theſe ſublime Matters.

Corollary III.

Hence, we may diſcover the Errors and Impieties of *Spinoſa*, and *Hobbes*; and the Miſtakes of a *latter Philoſopher*, I mean (the otherwiſe *Ingenious*) Mr. *Lock*. The *firſt* of theſe, conſidered this *univerſal Syſtem of Things*, as a kind of a *Huge-brute-animal*, actuated by a fatal, neceſſary, unintelligent, undeſigning Principle; without either Wiſdom or Choice. The *Second*, conſidered *humane Nature* (not as it really is in it's preſent ſtate of *Probation* and *Purification* a Mixture of moral and natural Good and Evil, but) in it's *Diabolical* and *reprobrated* Eſtate: Not as Groaning under it's preſent State of Corruption, and waiting and panting *for the glorious Liberty of the Sons and Children of God*; but as it will be in an habitual confirm'd Eſtate, of the *Anarchy* and Rebellion of it's Faculties one againſt another. In a Word, he conſidered *humane Nature* only, as it is in the worſt of Men; or as it is ſuppoſed to be at laſt in a State of *final Impenitence*, and harden'd Impiety; and this he took as his *Original* to copy after, and his M*odel*, whereupon he was to frame his *humane Creature*: And it muſt be allowed he has wrought it up to *the Life*. The *Third* conſidered M*an*, and his *Faculties*, not indeed in their already *reprobated* and *Helliſh Eſtate*, but as he really now is, in the World, a compoſition of moral and natural Good and Evil: And this State he has very fairly and juſtly repreſented ſo far as it goes. But then, either having no Notion, or at leaſt no Regard, to his *higher Faculties* (which in natural and lapſed Man, ly Buried under the Rubbiſh of his preſent Corruptions and Senſuality;) nor to his *regenerated*, *redintegrated* and *reſtabliſhed Eſtate*, (to which he muſt be reſtored before he can reach the *End* of his *Being.*) No not ſo much as to conſider Man, as he really is, a *fall'n, depraved, vitiated* Creature, (in which State his *lower*, his *rational* Faculties are impaired; his *higher* Faculties, in ſome meaſure *obliterated*, at leaſt Buried and Oppreſſed by the load of preſent Corruption and Senſuality: And all of them in a State of *Anarchy*, Rebellion, and Contrariety one to another.) I ſay, from having no regard to thoſe *other* different, *real* Eſtates of *humane Nature*, his Accounts of it's Faculties, are *Lame* and *Imperfect.* His *Principles* when apply'd (by himſelf or his Diſciples) to Subjects (to which Faculties are appropriated, higher than thoſe he *elicits* out of the meer lapſed State of humane Nature) of a more elevated Order (ſuch as *Chriſtianity* and it's *Holy Myſteries*, *Faith*, *Grace*, *Divine Revelation*, and *Inſpiration*, and the Means of Man's Recovery) debaſe theſe into *meer Heatheniſh Morals*, or *Humane Philoſophy*, and ſink the *Oeconomy* of *the whole Wiſdom of the Godhead*, even below the poor Contrivances and barren Speculations of many of the *Gentile Sophiſts.* But thoſe who fully underſtand the *Principles*, and are convinced of the *Truth* of the *Propoſitions*, I have laid down, will eaſily perceive the ground of the Errors and Miſtakes of theſe Three

Setts of *Philoſophers*: And be able to anſwer their Arguments without my being obliged to detail them.

Propoſition XXIII.

In the *Analogy of Things*, and Order of Nature, as the *material World*, is to *Univerſal Space*, it's higheſt Limit and Boundary, ſo is the *Spiritual World* to the *ſupreme and abſolute Infinite*, the higheſt Limit and Boundary of all Things.

Demonſtrat. This is evident from *Lemma* 1, with *Prop.* 9. and 17. There is a Beautiful *Analogy*, and Uniformity running thro' the whole *Syſtem* of Creatures. The *Viſible* and the *Created*, are *Images* of the *Inviſible* and of the *Increated*. The *Syſtem* of intelligent Beings are more exalted, more noble, and more immediate *Images* of the *ſupreme Infinite*. The *Analogy of Things* runs quite through the whole *Syſtem* of Creatures, up to their original Pattern and *Architype* in the Divine Nature, in a continued Subordination and Scale; according to their reſpective Natures. The *material* World is an *Image* of the *ſpiritual* World, as the *ſpiritual* World is of the *ſupreme Infinite*. As *Infinite Space* is the *Locus* and Boundary of the *material* World, ſo is the *ſupreme Infinite*, the *Analogical Locus* (in whom *they all Live, Move, and have their Being*) and the *Omega* of all Things, *Spiritual* and *Material*. And as *Space* is *Similar* to a *ſpiritual* Subſtance, ſo is that to the *Divine Subſtance*, therefore, *&c.* q. e. d.

Corollary I.

Hence *material* and *ſpiritual* Subſtances, are both of them *extended*; for ſince the *material* World, is to *univerſal Space*, as the *ſpiritual* World, is to the *ſupreme Infinite*; and ſince both *Matter* and *Space* are extended, ſo alſo muſt ſpiritual Subſtances be: And the *Divine Ubiquity*, and *Omnipreſence*, not *Virtually* only, but *Subſtantially* and *Eſſentially*; makes it not unlikely that there may be, in the *Divine Subſtance*, a reſemblance of *Extenſion* (ſo far as a reſemblance and ſimilitude of Subſtances can reach; between a *relative Infinite*, ſuch as *univerſal Space* is, and the *ſupreme Infinite*) but infinitely more pure and perfect, than that of created *Space* is, or can be.

Corollary II.

Hence *Matter* and *Spirit* are Oppoſits in every other Quality, except in that of *Extenſion*; for ſince by *Converſion of Ratio's*, the *material* World, is to the *ſpiritual* World, as infinite *Space* is to the *ſupreme Infinite*; and and ſince theſe two laſt, to wit, *univerſal Space*, and the *ſupreme Infinite*, are oppoſits in every other Quality, but in a reſemblance of Subſtances, and that too, at an *abſolutely Infinite* Diſtance, as is evident at firſt view; therefore the *other Two* muſt be oppoſite, in every other Quality but *Extenſion*, for tho' *extended Matter* be diviſible by being *Extended*; yet *Space* is not actually to be divided; or one part of it ſeparated from another. Since it is the *univerſal Locus* of, and penetrates all Bodies: And it is in *this* Senſe, that the oppoſition of theſe two Qualities in *Body* and *Spirit*, is meant here.

Propoſition XXIV.

By the *Analogy of Things*, and according to the Order of Nature, a *Spirit* is an *extended*, *penetrable*, *active*, *indiviſible*, *intelligent* Subſtance.

Demonſtrat. By *Def.* 2. *Matter* is an *extended*, *impenetrable*, *paſſive*, *unintelligent*, *diviſible* Subſtance: And ſince by the *preceding Corollary*, *Matter* and *Spirit* are in every other Quality oppoſite, except in that of *Fxtenſion*; therefore in place of all the qualities in the *Definition of Matter*; putting their Oppoſits, excepting in that of *extended*

extended Subſtance, (for *Extenſion* muſt imply a Subject) and then a *Spirit* will become, according to the *Propoſition*, an *extended*, *penetrable*, *active*, *indiviſible*, *intelligent* Subſtance. I have choſen the Word *Intelligent*, in this, and it's oppoſite *Unintelligent*, in the other Definition. To wit, in that of *Body*, rather than that of *Thinking*, becauſe *Intelligence* is the Source and Principle of *Thinking*, and expreſſes the *whole* of all the Faculties of *ſpiritual* Subſtances.

Corollary I.

Hence, in reſpect to their Subſtances only, a *material* Subſtance is an infinitely condenſed, or incraſſated, *ſpiritual* Subſtance: And on the other Hand, a *ſpiritual* Subſtance, is an infinitely rarify'd, or refin'd material Subſtance. As we have it in Holy Writ, there is a *natural* (or material) *Body*, and *there is a ſpiritual*, and *a glorified Body*. For ſince *Matter* and *Spirit*, have the Foundation of their Qualities common to both, to wit, an *extended* Subſtance: Since all their other Qualities are the one, reſpectively the Oppoſite or Negative of the other. Since *rarifying* any Quality in *Body* and *Spirit*, is ſubtracting from it's Intenſion and Energy, and therefore an infinite Rarefaction of a Quality, is ſubtracting it intirely; and there being no *mean* between *Penetrability* and *Impenetrability*, between *Paſſivity* and *Activity*, *Diviſibility* and *Indiviſibility*, *Intelligence* and *Unintelligence*, they being contrary and Oppoſite; therefore, the infinite Rarefaction of the one Quality, is the Poſition of it's contrary; for tho' the finite *Subtraction* of a *negative* Quality (admitting no *mean*) puts nothing, yet the infinite *Subtraction* of ſuch a *negative* Quality puts the *Affirmative* (thus $-02\times-\ominus=+0$. but $-\infty 0\times-\ominus=+\ominus$) therefore in M*atter*, *ſubtracting infinitely*, all it's *poſitive* Qualities, or which is the ſame, (by the *preceding Corollary*) in M*atter*, *Subtracting infinitely*, the *negative* Qualities of *Spirit*, and then a *material* Subſtance will become a *ſpiritual* Subſtance; but ſince an infinite Rarefaction, of a contrary Quality, is the ſame with an *infinite Subtraction* of that contrary Quality, and ſince the ſame manner of Reaſoning holds good in an *infinite Condenſation*, of the Qualities in *Spirit*. Therefore in reſpect of their *Subſtances* only a *material* Subſtance, *&c.* q. e. d. The Caſe in ſhort, as I conceive it, is thus. A *ſpiritual* Subſtance, when infinitely condenſed and *incraſſated*, looſes it's Qualities of *Penetrability*, *Activity*, *Indiviſibility*, and *Intelligence*. Theſe being lock'd up, and as it were *crampt*, in this *Condenſation* of their *Subſtratum* (or the Subſtance in which they eſſentially inher'd,) thus *infinitely Compreſs'd*. The *Actuality* (as the *Metaphiſicians* ſpeak) of theſe *ſpiritual* Qualities being thus ſhut up and impriſon'd, tho' their *Potentiality* be not quite deſtroyed, and thus a *craſs*, *extended*, *impenetrable*, *paſſive*, *diviſible*, *unintelligent* Subſtance is Generated, which we call *Matter*, but when this *Matter* thus form'd of a *ſpiritual* Subſtance, is again *infinitely* refin'd, and exalted, theſe *Powers*, and *Qualities* are unlooſed, ſet at freedom again, and exert themſelves as formerly, and thus become what they were originally made. But we muſt take care not to imagine that any *finite Subtilſation*, *Diviſion*, *Refinement*, or *Exaltation* of groſs *Brute-matter*, can in any the leaſt degree, by any finite created Powers whatſoever, bring it to any but an infinitely diſtant Approach to this ſtate of *Spirituality*; ſince it has been demonſtrated, *in the firſt Chapter of this Part*, that no Finite how great ſoever, can be any finite Part, of any *relative Infinite* how ſmall ſoever: No Power, leſs than his, *who out of the very Stones cou'd raiſe* (by Virtue of their original *Potentiality*) *Children to Abraham*, can out of *material*, bring *ſpiritual* Subſtances, or on the contrary, convert theſe into thoſe.

Corollary II.

Since in aſcending from *material* Subſtances, there can be no ſuch thing, by the *Analogy* of Things and Order of Nature, as a *Jump* or *Leap*, from one extreme to another, without paſſing through the intermediate Steps; and ſince in *material* Things, there are Subſtances of all degrees of *Denſity*, and *Rarity*. *Earths* more Denſe than *Water*, *Water* than *Air*, *Air* than *Ether*, *Ether* than *Light*. So in the *ſpiritual* World, there muſt be *Spirits* of all degrees of *Rarity*, the one *Sett* and Rank, more pure, and refin'd, than the other, in a perpetual *Scale*, 'till they aſcend ſo near the *ſupreme Infinite*, as Creatures can approach their *Creator*, or *Finites* the *abſolute Infinite*. And by the ſame *Analogy of Things*, as in the *material* World, theſe ſeveral Orders of Bodies, *Earth*, *Water*, *Air*, *Ether*, and *Light*, have their proper *Places*, *Elements*, and *Centers*, where they reſt, and whether they tend, and out of which they cannot be detain'd but by *Violence*; ſo in the *ſpiritual* World, there are *Centers*, *Spheres*, and *Elements*, of ſeveral Orders of *Spirits*, the one more pure, and refin'd than the other, (the more pure ſtill penetrating the leſs pure,) where they reſt, and continue, to which by their *ſpecifick* Degree of Purity, they are confin'd, out of which they cannot be detain'd but by *Violence*; all in a Subordination one to another, depending on their particular degrees of Purity, penetrating one another without Confuſion or Contrariety, 'till they arrive as near as is poſſible to the *ſupreme Infinite*, who penetrates the whole *Syſtem* of Creatures.

Corollary III.

Since by *Prop.* 15. the *Deſires*, are the *Cardinal* Faculty of intelligent Beings, infinitely *Active*, and Powerful, belonging to that Principle in them, which is appropriated to the *ſpiritual* World. By theſe *Deſires* therefore, thoſe of the ſame *Element*, and ſame Degree of Purity, are enabled to communicate one with another: But ſince the more pure penetrate the leſs pure, but not *vice verſa* (as is plain from *Corollary* 1. of the *preceding Propoſition*,) the more pure may penetrate the leſs pure, contrary to their *Deſires*; but not *vice verſa*, this Superiority of the more pure, over the leſs pure, being a neceſſary conſequence of the greater degree of Purity and Perfection. For as in the *material* World, the *Sun* purifies and rarifies Terreſtrial Bodies, the nearer they approach, or are brought to him: And at laſt converts them into his Subſtance. So in the *ſpiritual* World, the *Sun's* Pattern, and *Architype*, the *Sun of Righteouſneſs*, renders thoſe *Spirits* the more pure penetrating (and as it were *Deifies* their intimate Subſtances) whoſe *Elements* or Region is neareſt him. By which, they more nearly partake of his Nature who penetrates the whole *Syſtem* of Beings.

Corollary IV.

Hence, ſince the *ſupreme Spirit*, in compounded intelligent Beings is more pure (as being the higheſt Principle; and that *Breath of Life*, which they had immediately from the Divine Subſtance) than the *rational Soul*, the *firſt* penetrates the *latter*, and the *latter* is but the *Medium*, and is it ſelf but of an intermediate Nature, between the two *Extremes*, *Body* and *Spirit*, coupling them together by it's intermediate Subſtance. And in their primitive Order and Inſtitution, they were in a due Subordination, one to another. The *Body* to the *rational Soul*, and *both* to the *ſupreme Spirit*: And in this Subordination, preſerved and maintain'd, and diligently cultivated, according to their reſpective Dignity; in the *Will's* obeying, and approving of; and in the *whole Compound's* purſuing the practical Inferences deduced in this *State*, did the *original Rectitude* of theſe compounded intelligent Beings conſiſt. And in the Contrariety, Contradiction, and Rebellion, of theſe different *Principles*, one againſt another; in the *Will's* obeying, and approving of, and the *whole Compound's* purſuing, the practical Concluſion's deduced under this State of *Anarchy*, does the *Fall*, *Lapſe*, and *Degeneracy* of this *Sett* of intelligent Beings conſiſt. And for the reſtoring, rectifying and re-eſtabliſhing the primitive Order and State, of theſe three Principles, to a habitual and laſting Subordination, was the Incarnation of the *Divine* LOGOS, and whole *Oeconomy* of the Redemption of Man.

Corollary V.

Hence, the *ſupreme Spirit*, may be Dark, Dead, and almoſt quite Obliterated, as to it's *ouvert* Acts (the *Principle* it ſelf, being eſſential to, and interwoven with, the moſt intimate Natures of all intelligent Beings,) when the *rational Soul* is full of *Ideas*, Pictures, and Images of Things. And on the other hand the *ſupreme Spirit* may be full of *Light*, *Brightneſs*, *ſubſtantial Knowledge*, *Joy* and *Peace*. When the *rational Soul*, is but Weak, Faint, and Languid, and almoſt void of all *Ideas* and Images; theſe being not only ſeparable, but at laſt to be *actually* ſeparated. (So far at leaſt as the acts of the *rational Soul*, can affect the *ſupreme Spirit*,) when the LOGOS (that *eternal and eſſential Word of God*) *which is quick and powerful, and ſharper than a Two-edged Sword, ſhall pierce, to the dividing aſunder the Soul and Spirit.*

SCHOLIUM GENERALE.

Thus I have endeavoured to give ſome faint, and imperfect Images, of the higheſt and moſt ſublime Speculations of *Religion* and it's *Philoſophy*, in the *preceding Propoſitions* and *Corollaries*. And tho' I am very far from thinking, they are even juſt, and compleat Images, and ſuch as might be drawn from the ſame Principles, by a more ſkilful Hand. Yet I am fully convinced, the *Propoſitions* and *Corollaries* themſelves, are true and juſt, as to their Subſtance; whatever may be in my way of explaining or demonſtrating them; ſo far at leaſt, as *Reaſon* can find out the *Truth* in ſuch *ſublime Myſteries*. I am alſo well ſatisfied, that *Reaſon* can with any propriety or juſtneſs, apply it ſelf to Objects to which it is not *adequate* and appropriated, after no other manner, but by ſuppoſing thoſe Objects, to which it is *adequate*, *Ima-*

ges or Repreſentations, of thoſe other Objects, to which it is not adequate. There being no other poſſible way for *Reaſon* to find a *Medium* of it's Knowledge, of Objects that are convey'd to the rational Underſtanding, by none of the bodily Senſes. (as the proper Objects of it's Faculties are.) And there being an abſolute neceſſity, from the *ſimplicity* and *uniformity* of the *Divine Nature*, and of his manner of Operating, that all his Works ſhou'd be Reſemblances and *Images* one of another, (more or leſs perfect, according to their reſpective Natures,) and alſo of himſelf, their *original Pattern* and *Architype*. This manner of Reaſoning, and this *Medium* of rational Knowledge, duly inſtituted, muſt be juſt and true, as far as it reaches. And thus far *Reaſon* can go, and not one ſtep further, in the Knowledge of ſuperior Objects; it can frame and form *Images* of theſe ſuperior Objects, from what it finds and certainly knows of the *material* World, to which it is in ſome meaſure adequate. *Images* I ſay, not *Metaphorical* only, but *Real* and *Phyſical*, as a Statue repreſents a Man, a Picture in *Miniature*, one from the Life, as a *Seed* (which is really the plant it ſelf in little) does a grown plant, or an *Embryo*, the adult Animal: This is the Boundary of *Reaſon* in theſe ſuperior Objects. And it is very obſervable, that there are various Images in Nature, and in the *intellectual Species* of Things (fram'd upon what the Senſes have already convey'd into the rational Underſtanding) of all the moſt unconceivable, the moſt abſtruſe, and ſublime *Myſteries* of Religion and it's Philoſophy; each ſuperior to another. Can there be a more perfect, noble, or lively Image in this lower World, of the *Divine Nature*, *Light*, *Benignity*, *Greatneſs*, and *Power* required, than that of the *Sun*, in reſpect of our *Planetary Syſtem*. His Beams ſhine, and are tranſmitted through all the *Planetary* and *Cometary* Regions, even into the *Syſtems* of the *fix'd Stars*. He *attracts* all the *Planets* and *Comets* in our *Syſtem*, and is the Source of all their regular, uniform, and conſtant Motions and Influences. He warms, cheers, enlivens, and fertiliſes all the *Elements*, *Vegetables*, and *Animals*; and is indeed the *material Deity* of this inferior World. Is there not a plain and obvious Image of the EVER-BLESSED-TRINITY IN UNITY, in every Order of Creatures? In the three Dimenſions of Bodies? In Nature's never riſing above the *Third* Dimenſion in her regular Operations as was ſhown in *Scholium Prop.* 12? In the *Three* infinite Powers of *univerſal Space*? In the *Three* generical Diviſions of Objects? *Matter*, *created Spirit*,

Spirit, and the *Supreme Infinite* in the *three* Diſtinctions and *Univerſal Principles* that comprehend the whole of material Intelligent Beings? The *Faculty*, *Object*, and the *Congruity* or *Incongruity* between theſe? The *Profane* and Ignorant may make a Jeſt of this *Ternary* Chain, and aſcribe it to Chance or Fortune. But the *Analogy of things*, and the regular Uniformity in Nature, make it evident to a *Demonſtration*; that it muſt have had its Riſe in its *Original Pattern* and *Architype*, the *Divine Nature*. Even the Eternal *Generation* of the *Second* Principle in the *Godhead*, of the *Firſt*, and the Eternal *Proceſſion* of the *Third* Principle from the *Firſt* and *Second*, comes evidently out of this *Analogical Ternary*, when elevated to its Origin in the Divine Nature; as was ſhewn in *Scholium* 2. *Prop.* 17. And the impoſſibility of increaſing or multiplying the Divine and *Supreme Infinitude*, even by itſelf, ſo far as that it is uncapable of Increaſe, or Diminution; as was ſhewn in *Corollary* 2. *Prop.* 12. pictures forth, the *Unity* of the Divine Nature, in theſe *three* Relations of the *whole* to the *whole*. How noble a Repreſentation in Created things, is the *Univerſal Space* of the *Divine Ubiquity*, *Infinitude*, and *Spiritual Nature*? how lively a Picture in the *Intellectual Species* of things, of *Creation*, or of Gods producing the things that be, out of the things that were not, is that *Propoſition* Demonſtrated *Corollary* 2. *Prop.* 2. $\frac{1}{1+1+1+1+1+1\ \&c.}\times 0=\infty\times 0=1.$ or $\overline{\odot+\odot+\odot+\odot+\odot\ \&c.}\times 0=$

$o = \infty \quad \odot \times o = \odot$? The production of a *Plant* from its *Miniature* in the Seed; and of an *Animal* from an *Animalcule*, is an aſtoniſhing Repreſentation of the Reſurrection of the Body. Theſe and many ſuch Reſemblances, and Images in Nature, in the *Senſible* and *Viſible* things, and in the *Intellectual Species* of things, derived through the Senſes; might be brought to illuſtrate and confirm the greateſt Difficulties and moſt abſtruſe Myſteries of *Religion*, and its *Philoſophy*. So certain and univerſal is the *Beautiful Analogy of Things*, and ſo careful has the *Kind* and *Bountiful Author* of our Beings been, to ſupply us with Evidences in our *lower Faculties*, and *lapſed* Eſtate, of *thoſe Truths* he requires us to believe and receive. The *full* and *compleat* Conception and Knowledge of which, belong not but to our *Superiour* Faculties, and to our *Reſtored* and *Re-eſtabliſhed* Eſtate. May we then uſe the Aſſiſtances, *Reaſon*, and the *Divine Bounty*, has afforded us, (I may almoſt ſay, even beyond and out of their Natural Order) for increaſing our *Faith*, Cultivating and expanding our *Superiour Faculties*, reſcuing us out of our *Degeneracy* and Corruption, *into the Glorious Liberty of the Sons and Children of God*, and then, *in his Light we ſhall ſee Light*, Amen.

CHAP. III.

Of the USE of the Arithmetick fo Infinites.

§ I. IN Arithmetical Progreſſion; in which let a denote the firſt, v the *laſt* term, x the Difference, t the Number of Terms, and z the Sum of all the Terms, which in an aſcending Progreſſion are a, $a+x$, $a+2x$, $a+3x$, *&c.* but in a deſcending Progreſſion a, $a-x$. $a-2x$, $a-3x$, *&c.*

Having any three of theſe five a, v, x, t, z. you may find the other two by help of theſe two Lemma's,

$$\begin{array}{l}\text{Lem. 1.}\\ \text{Lem. 2.}\end{array}\left\{\begin{array}{l} v = a + tx - x\\ 2z = t \times \overline{a+v}\end{array}\right\}\begin{array}{l}\text{but } v = a - tx + x,\\ \text{when it deſcends.}\end{array}$$

I ſhall here only treat of aſcending Progreſſions, judging thoſe that deſcend as not properly belonging to the Arithmetick of Infinites.

Now in aſcending Progreſſions both t and v are infinite.

$$\begin{array}{l}\text{Therefore } \textit{Corol } 1.\\ \text{And } \qquad \textit{Corol } 2.\end{array}\left\{\begin{array}{l} v = tx\\ 2z = tv\end{array}\right\}\begin{array}{l}\text{in the Caſe of}\\ \text{Infinites.}\end{array}$$

Becauſe Infinites are not all equal, but vary in their Ratio's to one another, as much as finite Quantities do; therefore to avoid confuſion, I ſuppoſe $v = \infty \times 1 = 1 + 1 + 1 + 1 + 1 + 1$ *&c.*

So from *Corol.* 1. $t = \frac{\infty}{x} = \infty \times \frac{1}{x} = \frac{1}{x} + \frac{1}{x} + \frac{1}{x} + \frac{1}{x} + \frac{1}{x} + \frac{1}{x}$ *&c.*

Prop. 1. $z = \frac{\infty^2}{2x}$. This follows from ſubſtituting the Value of t, *viz.* $\frac{\infty}{x}$ in *Corol.* 2.

Exemp. 1. Let $x = 1$. then $1 + 2 + 3 + 4 + 5$ &c. $= z = \frac{\infty^2}{2}$, that is, the Sum of all the natural Numbers continued *in infinitum* is equal to half the Square of Infinite: and here it is to be noted, that in this Caſe only $t = v = \infty \times 1 = 1 + 1 + 1 + 1 + 1$ &c.

Exemp. 2. Let $x = \frac{1}{2}$, then $1 + 1\frac{1}{2} + 2 + 2\frac{1}{2} + 3 + 3\frac{1}{2}$ &c. $= z = \infty^2 =$ to the Square of Infinite.

And thus may you find the Ratio between the Sum of any aſcending Arithmetical Progreſſion, and the Square of Infinite; and Note that by Infinite, is always underſtood Infinite in General, or Infinite of the ſimpleſt Nature and Loweſt Degree, $1 + 1 + 1 + 1$, &c. unleſs it be otherwiſe expreſsly declared.

Corol. $\infty \times \frac{1}{\sqrt{2x}}$ is the Root of a Square, which Square is equal to the Sum of any Arithmetical Progreſſion aſcending *in infinitum.* *Exemp* Let $x = 2$, then $\infty \times \frac{1}{2}$ (or an infinite number of $\frac{1}{2}$) is the Root of a Square equal to the Sum of that Progreſſion, *viz.* $1 + 3 + 5 + 7$ &c. $= \overline{\frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2}\ \&c.}\,|^2$

Corol. 2. Let $a = \infty n$, $v = \infty m$. $t = \infty p$. Theſe values of a, v, t, being ſubſtituted in Lem. 2. will give you $2z = \infty p \times \overline{\infty n + \infty m} = \infty^2 \times \overline{pn + pm}$, or $z = \frac{\infty^2 \times \overline{pm + pn}}{2}$, and the common Difference $x = \frac{m - n}{p}$, as you may eaſily find from *Lem.* 1.

You may expreſs the Sum z otherwiſe, for $t = \frac{v - a}{x}$ by *Lem.* 1. Therefore $\frac{v - a}{x} \times \overline{v + a} = 2z$ by *Lemma* 2*d.* that is $z = \frac{v^2 - a^2}{2x} = \frac{\infty^2 m^2 - \infty^2 nn}{2x} = \frac{\infty^2 \times \overline{mm - nn}}{2x}$,

Corol. 3. From *Prop.* 1. and *Corol.* 2. it is evident that in two Arithmetical Progreſſions having the ſame common Difference x, the Sum of that whoſe terms are infinite, is to the Sum of that whoſe terms are finite, as $m^2 - n^2$ to 1. For the Sum of the firſt, by *Corol.* 2. is $\infty^2 \times \frac{m^2 - n^2}{2x}$, x the Sum of the other, by *Prop.* 1. is $\infty^2 . \times \frac{1}{2} x$.

Corol. 4. From hence may be ſolved this Problem. Any Arithmetical Progreſſion being given as a, $a + x$, $a + 2x$, $a + 3x$, *&c.* whoſe terms are finite; to find another conſiſting of Infinite

Terms, that ſhall have the ſame Difference x, and whoſe Sum ſhall be equal to the Sum of the given Progreſſion. *Solution.* $m^2 - n^2 = 1$ from *Corol* 3. *& ex hypotheſi.* Therefore $m^2 = 1 + n^2$; ſo to find m and n, is an indetermin'd Problem, whoſe Solution by the known Methods will give you $m = \frac{e^2 + 1}{e^2 - 1}$, $n = \frac{2e}{e^2 - 1}$, where e is any number ($\angle$ 1) taken at Pleaſure. So then theſe Values of m and n being ſubſtituted in the Values of a and v, of *Corol.* 2. will give you the firſt Term $a = \infty \times \frac{2e}{e^2 - 1}$, and the laſt $v = \infty \times \frac{e^2 + 1}{e^2 - 1}$, and calling the common Difference x, you will have a Progreſſion, each of whoſe terms is infinite, and whoſe Sum ſhall be equal to the Sum of any other Arithmetical Progreſſion, whoſe firſt term is finite, and the common Difference x; and becauſe e is an Arbitrary number, therefore you have as many of ſuch Progreſſions as you pleaſe, to anſwer the *Problem.*

Exemp. Let the given Progreſſion be $1 + 2 + 3 + 4 + 5$ *&c.* where $x = 1$, ſo the Sum thereof is $= \infty^2 \times \frac{1}{2}$ (as in *ex.* 1. *Prop.* 1) now taking $e = 2$, you will have $n = \frac{2e}{e^2 - 1} = \frac{4}{3}$ *&c.* $m = \frac{e^2 + 1}{- 1} = \frac{5}{3}$, which from the ſecond expreſſion of *Corol.* 2. will give the Sum of the ſeries ($\infty \times \frac{4}{3}$, $1 + \infty \frac{4}{3}$, $2 + \infty \frac{4}{3}$, $3 + \infty \frac{4}{3}$, *&c.*) $\infty^2 \times \dfrac{m^2 - n^2}{2x} = \infty^2 \times \dfrac{\frac{25}{9} - \frac{16}{9}}{2x} = \infty^2 \times \frac{1}{2}$, which is the ſame with that of the given Progreſſion conſiſting of finite terms.

Schol. The Problem may be made more general, and the Solution as eaſy, if it were required, that the Sum of the Series conſiſting of infinite Terms, ſhould be to that of the other conſiſting of finite Terms in any given Ratio of r^2 to s^2, for then it muſt be to find m and n, ſuch that $m^2 - n^2, 1 :: r^2 : s^2$.

Prop. 2. Let all things be as in *Prop.* 1. except the laſt Term, which here we ſhall ſuppoſe $v = \infty n$, in which Caſe I ſay $\left\{ z = \infty^2 \times \dfrac{nn}{2x} \right\}$

Exemp 1. Let $n = 2$, $x = 1$; $a = 1$, ſo the Progreſſion will be 1, 2, 3, 4, 5, *&c.* till the laſt Term be $\infty 2$, I ſay the Sum $1 + 2 + 3 + 4 + 5$, *&c.* $= z = \infty^2 \times 2$ = double the Square of Infinite.

§. II. In Geometrical Progreſſion, let a denote the firſt, and v the laſt Term, the Ratio of the Terms, that of r to s, t the Number, and z the Sum of all the Terms of any Geometrical Progreſſion, which will be $a, \dfrac{sa}{r}, \dfrac{s^2 a}{r^2}, \dfrac{s^3 a}{r^3}, \dfrac{s^4 a}{r^4}$.

Of theſe five things, *viz.* the firſt Term a, the laſt Term v, the Ratio of the Terms $\dfrac{r}{s}$, the number t, and the Sum of the Terms z, having any three, you may find the other two by theſe two *Lemma's*.

$$\left.\begin{array}{l} \text{Lem. 1. } v = \dfrac{\overline{s}|^{t-1}}{\overline{r}|^{t-1}} \times a \\ \text{Lem. 2. } sz + ra = rz + sv \end{array}\right\}$$

From *Lemma* 2*d.* it follows that $z = \dfrac{ra - sv}{r - s}$ when the Progreſſion deſcends, that is, when $r \angle s$.

But when the Progreſſion aſcends, that is, when $r \urcorner s$ then from *Lemma* II. it will be $z = \dfrac{sv - ra}{s - r}$

Caſe 1. In deſcending Progreſſions where the number of Terms are infinite, the laſt Term v will be $= 0$.

Prop. 1. In all deſcending Progreſſions, whoſe number of Terms are infinite, and firſt Term finite, the Sum of the Progreſſion is a finite quantity *viz.* $z = \dfrac{ra}{r - s}\Big\}$

Corol. 1. Let $a = r$, then $z = \dfrac{r^2}{r - s}$

Exemp. Let $r = 1$, $s = \frac{1}{2}$, then $1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16}$ *&c.* $= 2 = \dfrac{r^2}{r - s} = z$

Prob. Having the firſt Term a, and the Ratio of the Terms $\dfrac{r}{s}$ of any Geometrical Progreſſion deſcending in *infinitum*, till $v = 0$, to find another Progreſſion deſcending in *infinitum*, whoſe firſt Term ſhall be any given number b, and its Sum equal to the Sum of the given Progreſſion.

Sol. Let m to n be the Ratio of the Terms of the Progreſſion ſought; now $\frac{ra}{r-s}$ is the Sum of the given Progreſſion, by *Prop.* 1. and for the ſame reaſon $\frac{mb}{m-n}$ muſt be the Sum of the Progreſſion ſought, therefore from the condition of the Problem ſought $\frac{mb}{m-n} = \frac{ra}{r-s}$, which gives $n = \frac{m \times \overline{ra - rb + sb}}{ra}$, where a, r, s, b are given, and m may be taken at Pleaſure; and ſo you have n from this Equation; and conſequently the Progreſſion ſought is found; for a Progreſſion is found, when you have the firſt Term b, and the Ratio of the Terms m to n.

Example. Let $r = 1$, $s = \frac{1}{2}$, $a = 1$; $b = \frac{2}{3}$, I aſſume $m = \frac{2}{3}$ $(= b)$ ſo the Equation will give $n = \frac{4}{9}$, therefore $1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8}$ *&c.* $= \frac{2}{3} + \frac{4}{9} + \frac{8}{27}$ *&c.*

And here it is to be noted that ſince m is taken at Pleaſure, the Problem is indetermined, and ſo you may find as many Progreſſions as you pleaſe, whoſe Sum ſhall be equal to the Sum of any given Progreſſion.

Schol. The Problem will be more general, if it be required that the Sum of the given Progreſſion $\frac{ra}{r-s}$ be to the Sum of the Progreſſion ſought $\frac{mb}{m-n}$ in any given Ratio h to k *viz.* $\frac{ra}{r-s} : \frac{mb}{m-n} :: h : k$, which gives $z = \frac{m \times \overline{ark + bhs - bhr}}{akr}$; where m is at Pleaſure.

Caſe II. In aſcending Progreſſions, whoſe number of Terms are Infinite, the laſt Term v will be $= \infty \times e$; but firſt I ſhall conſider theſe Progreſſions in which $e = 1$, that is, where the laſt Term is an infinite number of Units.

Prop. 2. $z = \infty \times \frac{s}{s-r}$ $(= \frac{sv}{s-r})$ for ra vaniſhes, becauſe a is finite, and v infinite.

But here it is carefully to be obſerved, that in all theſe Progreſſions it is neceſſary to make $a = r$, ſo that r will be the firſt and s the ſecond Term of the Progreſſion; and indeed in all Geometrical Progreſſions, there is a convenience of expreſſing the Ratio of the Terms by the two firſt Terms of the Progreſſion.

This being premiſed, it is evident that $\frac{s}{s-r}$ is the infinitely ſmall and equal part, of which an infinite number gives the Sum of any Geometrical Progreſſion aſcending in *infinitum.*

Examp. 1. Let $r = 1$, $s = 3$, then $\frac{s}{s - r} = \frac{3}{2}$, which ſhews $z = \infty \times \frac{3}{2}$, that is $1 + 3 + 9 + 27 + 81$ *&c.* $= \frac{3}{2} + \frac{3}{2} + \frac{3}{2} + \frac{3}{2}$ *&c.*

Examp. 2. Let $r = 1$, $s = \frac{3}{2}$, ſo $\frac{s}{s - r} = 3$, Ergo $z = \infty \times 3$, that is, $1 + \frac{9}{4} + \frac{27}{8} + \frac{81}{16}$ *&c.* $= 3 + 3 + 3 + 3$ *&c.*

Problem. To find a Progreſſion, which ſhall have any given number (a) for the equal part of which its Sum conſiſts. *Solution.* Let r be the firſt, and s the ſecond Term of the Progreſſion ſought, then (becauſe $\frac{s}{s - r}$ is the equal part for every Progreſſion) $\frac{s}{s - r} = a$ which gives $s = \frac{r\,a}{a - 1}$, ſo taking the firſt Term r at Pleaſure, the ſecond ſhall be $\frac{r\,a}{a - 1}$.

Examp. To find a Progreſſion whoſe Sum ſhall be $= \infty \times 2$. In this Caſe $a = 2$, ſo taking $r = 1$, it will give $\frac{r\,a}{a - 1} = 2$ which ſhews that the Sum of a Progreſſion, whoſe firſt Term is 1, and ſecond Term is $2 = \infty\,2$, or $1 + 2 + 4 + 8$ *&c.* $= 2 + 2 + 2 + 2$ *&c.*

Scholium. Becauſe r is taken at Pleaſure, therefore you may find as many Progreſſions as you pleaſe, whoſe Sums ſhall be all equal, becauſe each of them is $= \infty \times a$.

Prob. 2. Having any Progreſſion aſcending, to find another whoſe Sum ſhall be equal to the Sum of the given one. Let r be the firſt, s the the ſecond Term of the given Progreſſion; and m the firſt, n the ſecond Term of the Progreſſion ſought, then $\infty \times \frac{s}{s-r}$ is the Sum of the given one, and $\infty \times \frac{m}{m-n}$ is the Sum of the Progreſſion ſought, *Ergo* $\infty \times \frac{s}{s-r} = \infty \times \frac{m}{m-n}$, or $\frac{s}{s-r} = \frac{m}{m-n}$ which gives $n = \frac{rm}{s}$, m may be taken at Pleaſure, and ſo you have n.

Schol. So may you find a Progreſſion, whoſe Sum ſhall be to the Sum of the given one, in any given Ratio h to k. for then $\frac{m}{m-n} : \frac{s}{s-r} :: h : k$: ſo that $n = \frac{m \times \overline{sh + rk - sk}}{sh}$.

§ III. Before I proceed to other Progreſſions, it will be neceſſary to ſubjoin ſome things, which were omitted in § I. concerning Arithmetical Progreſſion, and which ſhould have immediately preceeded § 2.

Lemma. $z = \infty^2 \times \frac{1}{2x}$, when $v = \infty \times 1$. by *Prop.* 1. of § 1.

Prob. Having the common Difference x, and the laſt Term $v = \infty \times 1$ of any Arithmetical Progreſſion aſcending in *infinitum*; to find another Arithmetical Progreſſion, whoſe Sum ſhall be equal to the Sum of the given one.

Let e be the common Difference, $\infty \times n$ the laſt, and y the Sum of all the Terms of the Progreſſion ſought; then $y = \infty^2 \times \frac{nn}{2e}$: by *Prop.* 2. of § 1. Now becauſe $z = \infty^2 \times \frac{1}{2x}$ is the Sum of the given Progreſſion, therefore from the condition of the Problem $\frac{1}{2x} = \frac{nn}{2e}$, ſo $e = x\,nn$; you may take n at Pleaſure, and ſo you have e and conſequently the Progreſſion ſought.

Exemp. 1. Let the given Progreſſion be 1, 2, 3, 4, 5, &c. to $\infty \times 1$. where $x = 1$, ſo $e = nn$; calling $n = 2$, you have $e = 4$ for the common Difference of the Progreſſion ſought, *viz.* 1, 5, 9, 13, &c. to $\infty \times 2$. I ſay then that the Sums of theſe two Progreſſions are equal.

Corol. $n = \sqrt{\frac{e}{x}}$, ſo taking e at Pleaſure, you have n, as in the former Example, if you call e, 2, then $n = \surd 2$, ſo the Progreſſion ſought is, 1, 3, 5, 7, &c. to $\infty \times \surd 2$, whoſe Sum ſhall be equal to $1 + 2 + 3 + 5 + 6$ &c. to $\infty \times 1$. So that in ſolving this Problem, you may either make the common Difference, or the infinitely ſmall part (n) of the laſt Term, what you pleaſe; and becauſe one of the two may be taken at Pleaſure, therefore the Problem is indetermined, and conſequently you may find as many Progreſſions as you pleaſe, whoſe Sums ſhall each of them be equal to the Sum of the given Progreſſion.

Scholium. In the ſame manner you may find as many Progreſſions as you pleaſe, the Sum of each of which ſhall be to the Sum of the given one in any given Ratio of k to h; for then $\frac{nn}{2e} : \frac{1}{2x} :: k : h$, which gives $ke = h \times n^2$; ſo that of theſe two (e, n) taking one at Pleaſure, you have the other from this Equation.

Problem 2. Having the Sum $\infty^2 \times q$ of any Progreſſion, to find another that ſhall have a given common Difference e, and whoſe Sum ſhall be equal to the given Sum. Let $\infty \times n$ be the laſt Term of the Progreſſion ſought, then its Sum will be $= \infty^2 \times \frac{n^2}{2e}$; therefore by the condition of the Problem $\frac{n^2}{2e} = q$. ſo that $n =$

$\sqrt{2eq}$: but, e and q are given, therefore n is known.

Examp. Let $q = 1$, it is requir'd to find a Progreſſion whoſe Difference ſhall be 1, and its Sum $= \infty^2 \times 1$ or the Square of infinite; now becauſe $q = 1$, and $e = 1$, therefore $n = \sqrt{2}$, ſo that $\infty \times \sqrt{2}$ ſhall be the laſt Term of a Progreſſion 1, 2, 3, 4, 5, 6, 7, *&c.* whoſe Sum ſhall be $= \infty^2$; but by *Examp.* 2*d.* of *Prop.* 1. of § 1. if $x = \frac{1}{2}$, and v ∞, then the Sum $z = \infty^2$; *Ergo* $1 + 2 + 3 + 4 + 5$ *&c.* to $\infty \times \sqrt{2} = 1 + 1\frac{1}{2} + 2 + 2\frac{1}{2}$ *&c.* to $\infty \times 1$.

Examp. 2. Let $q = \frac{1}{2}$, and $e = 2$, then $n = \sqrt{2}$, ſo that a Progreſſion whoſe common Difference is 2, and laſt Term $\infty \times \sqrt{2}$ ſhall have its Sum $= \infty^2 \times \frac{1}{2} =$ (by *ex.* 1. *pr.* 1.) $1 + 2 + 3 + 4 + 5$ *&c.* to ∞.

§ V. *Lemma* $\frac{1}{1 - r|}e = 1 + er + \frac{e \times \overline{e+1}}{2} \times r^2 + \frac{e \times \overline{e+1} \times \overline{e+2}}{2 \times 3} \times r^3 + \frac{e \times \overline{e+1} \times \overline{e+2} \times \overline{e+3}}{2 \times 3 \times 4} \times r^4 + \frac{e \times \overline{e+1} \times \overline{e+2} \times \overline{e+3} \times \overline{e+4}}{2 \times 3 \times 4 \times 5} \times r^5$ *&c.*

Let us now conſider the various Progreſſions that will ariſe out of this Series, and what relation they have to infinite in general or $\infty \times 1$, and that I may proceed diſtinctly, I will reſolve it into ſeveral Caſes, beginning at the Simpleſt, where $r = 1$, and ſo proceed gradually to $r = 2$

$r = 3$

$r = 3$, *&c.* And where the Series is neither in an Arithmetical nor yet in a Geometrical Progreſſion, I ſhall endeavour to diſcover according to what increaſe the Progreſſion goes on; tho' in general that is plain enough from the *Lemma* of § 5.

Caſe 1. Let $r = 1$, which contains an infinite number of other Caſes, according to the Different values of e, the Progreſſion whereof I ſhall ſhow in the following Articles.

Artic. 1. $(e = 1.) \frac{1}{1-1} = 1 + 1 + 1 + 1$ *&c.* $= \infty \times 1.$

Artic. 2. $(e = 2) \frac{1}{\overline{1-1}|^{2}} = 1 + 2 + 3 + 4$, *&c.* $= \infty^{2}$

Artic. 3. $(e = 3) \frac{1}{\overline{2-1}|^{3}} = 1 + 3 + 6 + 10$ *&c.* $= \infty^{3}$

Artic. 4. $(e = 4) \frac{1}{\overline{1-1}|^{4}} = 1 + 4 + 10 + 20$ *&c.* $= \infty^{4}$

Now you are to obſerve that the Terms of any one of theſe Progreſſions is made up the of Sum of the Terms of the Progreſſion next preceeding; for inſtance, the third Term of the Progreſſion ∞^{3}, *viz.* 6, is the Sum of the three firſt Terms of the Progreſs $= \infty^{2}$; in like manner the fourth Term (20) of Progreſſion in Article fourth, is the Sum of the four firſt Terms in the Progreſſion of *Art.* 3*d.* and the 7*th* Term of *Art.* 3*d.* is the Sum of the Seven firſt Terms in *Art.* 2*d* It is to be obſerved likewiſe that the Terms of *Art.* 3*d.* are *Triangular Numbers,* ſince they are the Sums of the Natural Numbers of *Art.* 2*d.* and conſequently the Sum of the *Triangular* Progreſſion continued *in infinitum,* is equal to the *Cube* of Infinite. *Caſe* 2*d.* $r=2$.

Art. 1. $e=1$, then $\frac{1}{1-2} = 1 + 2 + 4 + 8$, &c. $= \infty \times 2$.

Art. 2. $e=2$, then $\frac{1}{\overline{1-2}|^{2}} = 1 + 4 + 12 + 32$, &c. $= \infty^{2} \times 4$.

Art. 3. $e=3$, then $\frac{1}{\overline{1-2}|^{3}} = 1 + 6 + 24 + 80$, &c. $= \infty^{3} \times 8$.

Art. 4. $e=4$, then $\frac{1}{\overline{1-2}|^{4}} = 1 + 8 + 40 + 160$, &c. $= \infty^{4} \times 16$.

Note, that the Terms of *Art.* 1*ſt.* are in a Geometrical Progreſſion in the Ratio of 1 to 2:

And it is obſervable that the terms of any following *Article* is made by the multiplication of the Terms of *Art.* 1ſt. into the reſpective Terms of that *Article* in *Caſe* 1. where *e* has the ſame Value. For inſtance the third Term of *Article* 2, is the Product of the third Term of *Artic.*

1. into the third Term of *Artic.* 2. of *Caſe* 1. and the fourth Term (*viz.* 160) is the Product of the fourth Term (*viz.* 8.) of *Artic.* 2. into the 4*th* Term (*viz.* 20) of *Artic.* 4*th. Caſe* 1ſt. And univerſally, let *A* denote any Term in any *Artic.* of *Caſe* 1. *B* any Term in *Artic.* 1*ſt* of *Caſe* 2*d.* And *C* any Term in any of the following *Articles* of *Caſe* 2*d* ; I ſay $C = AB$, taking *A B C* in the ſame order *i. e.* if *C* be the 5*th* Term, then *A* and *B* muſt alſo be the 5*th* Terms of their Progreſſions, and whatever Value (e) has in the Progreſſion of which *C* is the Term, it muſt have the ſame in that Progreſſion where *A* is the Term: *Examp.* To find the 7*th* Term of *Artic.* 3. of *Caſe* 2. Here *C* denotes the 7*th* Term of a Progreſſion in which $e = 3$: this ſhews that *A* is the 7*th* Term of *Artic.* 3. *Caſe* 1*ſt*, which multiplied into the 7*th* Term *B* of *Artic.* 1. *Caſe* 2*d* will give *C* the Term ſought.

Caſe 3*d.* $r = 3$

Art. 1. $e = 1$, then $\frac{1}{1-3} = 1 + 3 + 9 + 27$ *&c.* $= \infty \times \frac{3}{2}$.

Art. 2. $e = 2$, then $\frac{1}{\overline{1-3}|^{2}} = 1 + 6 + 27 + 108$, *&c.* $= \infty^{2} \times \frac{9}{4}$.

Art. 3. $e = 3$, then $\frac{1}{\overline{1-3}|^{3}} = 1 + 9 + 54 + 270$, *&c.* $= \infty^{3} \times \frac{27}{8}$.

Art. 4. $e=4$, then $\frac{1}{\overline{1-3}|^{4}} = 1+12+90+540$, *&c.* $= \infty^{4} \times \frac{81}{16}$.

Note, the firſt Series is a geometrical Progreſſion going on in the Ratio of 1 to 3. And the following Progreſſions are made out of this firſt, with the reſpective ones of thoſe in *Caſe* 1*ſt* in all reſpects, as thoſe of *Caſe* 2*d* already explain'd: for let *A* be any Term in any *Artic.* of *Caſe* 1. *B* a Term of the ſame order (with *A*) in *Artic.* 1. *Caſe* 3. and *C* a Term of the ſame order in any of the *Articles* of *Caſe* 3*d*. I ſay $C=AB$, where e has the ſame Value in *A* that it has in C. And ſo it is for all the ſucceding Caſes *in infinitum*: The firſt Series of any caſe, r (*viz.* where $e=1$) is always a geometrical Progreſſion in the Ratio of 1 to r; the following Progreſſions are made by the Multiplication of the Terms of this firſt Series into the reſpective Terms of thoſe in *Caſe* 1. As has been ſhewn in *Caſe* 1 and 2*d*.

Scholium. To have the firſt Progreſſion of every *Caſe*, let $e=1$, then $\frac{1}{1-r} = 1+r+r^{2}+r^{3}+r^{4}+r^{5}$ *&c.*

But $1+r+r^{2}+r^{3}+r^{4}$ *&c.* $= \infty \times \frac{r}{r-1} - \frac{r}{r-1} + \frac{r}{r-1} + \frac{r}{r-1} + \frac{r}{r-1}$ *&c.*

Before I conclude this Subject, it will be neceſſary to remove a very obvious and material Objection, *viz.* how it comes to paſs that the Sum of the natural Numbers $1 + 2 + 3 + 4 + 5$, *&c.* ſhould be equal to $\frac{\infty^2}{2}$ or half the Square of Infinite, as it appears by *Ex.* 1. of *Prop.* 1. of § 1. And yet the ſame Sum is $= \infty^2$ or the whole Square of infinite, as appears by *Art.* 2*d.* of Caſe 1. of the laſt *Lemma.* This ſeeming contradiction may be reconciled, if we ſuppoſe $\infty \times 1$ to be the laſt Term in the Progreſſion of *ex.* 1. *prop.* 1. § 1. which will make the Sum $\frac{\infty^2}{2}$; and $\infty \times \sqrt{2}$ to be the laſt Term in the Progreſſion of *Art* 2*d.* of Caſe 1. of the laſt *Lemma*; for that will make the Sum of the Progreſſion $= \infty^2$, as appears by *ex.* 1. of *prob.* 2. § 3. So that tho' it be the ſame Progreſſion going on in *infinitum*, yet the one goes on to a greater Infinite, *viz.* $\infty \times \sqrt{2}$ than the other which ends at $\infty \times 1$.

But the plain way of reconciling the Matter depends on the common Rules of Multiplication. For $1 + 2 + 3 + 4 + 5$ *&c.* $= \left(\frac{1}{1-1}\right)^2 = \frac{1}{1-1} \times \frac{1}{1-1}$, but $\frac{1}{1-1} = 1 + 1 + 1 + 1$ *&c.* and therefore $1 + 2 + 3 + 4 + 5$ *&c.* $= \overline{1 + 1 + 1 + 1 \text{ &c.}} \times \overline{1 + 1 + 1 + 1 + 1 \text{ &c.}}$

Let us now make an actual Multiplication of ſix Terms only, thus

$$\begin{array}{lccccccccccccl}
 & 1 & + & 1 & + & 1 & + & 1 & + & 1 & + & 1 & & \\
 & 1 & + & 1 & + & 1 & + & 1 & + & 1 & + & 1 & & \\
\hline
A. & 1 & + & 1 & + & 1 & + & 1 & + & 1 & + & 1 & & B.
\end{array}$$

1 + 1 + 1 + 1 + 1 + 1

1 + 1 + 1 + 1 + 1 + 1

1 + 1 + 1 + 1 + 1 + 1

1 + 1 + 1 + 1 + 1 + 1

C. 1 + 1 + 1 + 1 + 1 + 1 D

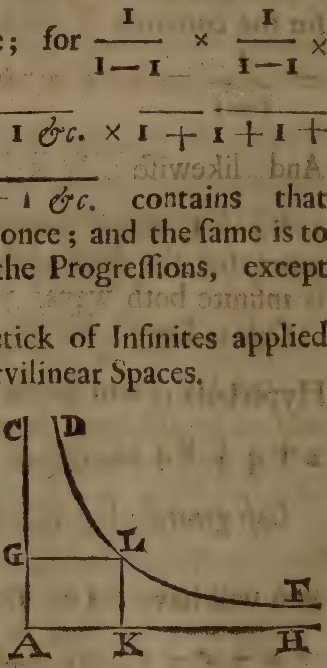
---

1 + 2 + 3 + 4 + 5 + 6 + 5 + 4 + 3 + 2 + 1

From the Proceſs it is evident, that adding the ſeveral Columns, their Sums make 1, 2, 3, 4, 5, 6. which is the greateſt, *viz.* *B C* (from which they deſcend in the ſame order to *D*) and this *B C* is always the number of Units in each Factor, ſo that if the number of Units multiplied into it ſelf, had been 1000, then *B C* the laſt Term of the Progreſſion aſcending from *A* would have been 1000; and conſequently if the number of Units multiplied into it ſelf had been ∞ × 1, then *BC* the laſt Term of the Progreſſion would have been ∞ × 1. Now the Progreſſion deſcends from *B C* to *D* in the ſame Order as it aſcends from *A* to *B C*; But *A B C* is the Sum of the Progreſſion 1, 2, 3, 4, 5, 6, *&c.* ending at *B C* = ∞ × 1; and this Sum *ABC* is but half the Product (of which *BCD* is the other) that is to ſay, half the Square of Infinite: Thus you ſee that the Proceſs of *Art.* 2. of Caſe 1. agrees exactly with that of *Prop.* 1. of § 1. only that of *Art.* 2. Caſe 1. gives you the Progreſſion twice over, and ſo makes it double of what it is in *Ex.* 1. *Prop.* 1. § 1.

Schol. From this Solution it appears that the Sum of the Progreſſion in *Art.* 3. Caſe 1. *viz.* $1 + 2 + 3 + 6 + 10 + 21$ *&c.* is not preciſely ∞^3 or the Cube of Infinite; for $\frac{1}{1-1} \times \frac{1}{1-1} \times \frac{1}{1-1} = \overline{1 + 1 + 1 + 1 \ \&c.} \times \overline{1 + 1 + 1 + 1 \ \&c.} \times \overline{1 + 1 + 1 + 1 \ \&c.}$ contains that Progreſſion oftner than once; and the ſame is to be conſidered in all the Progreſſions, except when $e = 1$.

§ VI. The Arithmetick of Infinites applied to Quadratures of Curvilinear Spaces.



Let *DLF* be any of the Hyperbola's, whoſe Aſymptots are *AC*, *AH*, let $AK = x$, $KL = y$, and the Equation comprehending all the Hyperbola's $yx^n = 1$.

By the common Methods $\left\{ CAKLD = \frac{1}{1-n} \times x^{1-n} \right\}$

And alſo $\left\{ HAGLF = \frac{n}{n-1} \times x^{1-n} \right\}$

Corol. 1. Let $x = 1$, then $CAKLD = \frac{1}{1-n}$, and $HAGLF = \frac{n}{n-1}$ }

Caſe 1. Let $n = 1$, ſo the Equation will be $yx = 1$ for the common Hyperbola, in which $CAKLD = \frac{1}{1-1} = 1 + 1 + 1$, &c. $= \infty \times 1$.

And likewiſe $HAGLF = \frac{1}{1-1} = 1 + 1 + 1 + 1$, &c. $= \infty \times 1$. From whence it appears that the Area of the *Apollonian* Hyperbola is infinite both ways.

Caſe 2. Let $n = 2$; ſo $yx^2 = 1$ defines the next Hyperbola in which $CAKLD = \frac{1}{1-2} = 1 + 2 + 4 + 8 + 16$, &c. $= \infty \times 2$.

Caſe general. If you reſolve $\frac{1}{1-n}$ into a Series, you will have $CAKLD = \frac{1}{1-n} = 1 + n + n^2 + n^3 + n^4 + n^5$, &c. and becauſe the Terms of this Series are in a geometrical Progreſſion aſcending (ſuppoſing $n \angle 1$) in the Ratio of 1 to n, therefore by *Prop.* 2. §. 2. the Sum thereof muſt be $1 + n + n^2 + n^3 + n^4 + n^5$, &c. $= \infty \times \frac{n}{n-1}$

Now becauſe $n \angle 1$, therefore $\frac{n}{n-1}$ is $\angle 1$; therefore in all theſe Hyperbola's (in which $n \angle 1$) the Area *CAKLD* will be an infinite Number of equal Parts, each of which (*viz.* $\frac{n}{n-1}$) is greater than 1. And hence is underſtood the meaning of the Geometers, who call theſe Spaces greater than infinite, that is greater than $\infty \times 1$ or infinite in general.

Corol. 2. In all the Hyperbola's (except the *Apollonian*) the Infinite Area *CAKLD* (adjacent to the Aſymptote *AC*) is equal to an infinite Number of the finite Area *HAGLF* (adjacent to the Aſymptote *AH*) in the ſame Hyperbola.

Demonſtration. $CAKLD = \infty \times \frac{n}{n-1}$ by the general Caſe, but $HAGLF = \frac{n}{n-1}$ by *Corol.* 1. § 6. Therefore

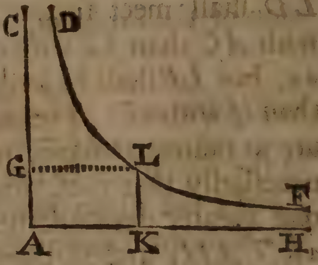
$\} CAKLD = \infty \times HAGLF \}$ *Q. E. D.*

Problem. Let $\infty \times e$ be the infinite Area *CAKLD* of any given Hyperbola, it is required to find another Hyperbola, whoſe infinite Space ſhall be to the Space ($\infty \times e$) of the given Hyperbola in any given Ratio, as of p to 1. *Sol.* Let $y x^n = 1$. be the Equation of the Hyperbola ſought, then by the general Caſe foregoing its Area is $= \infty \times \frac{n}{n-1}$; therefore by the condition of the Problem, $\frac{n}{n-1} . e :: p . 1$; which will give $n = \frac{pe}{pe-1}$; ſo that $y\,\overline{x|}^{\frac{pe}{pe-1}} = 1$ is the Equation to the Hyperbola ſought; but p and e are given numbers, and therefore this is a known Equation, and conſequently the Hyperbola defined by it is alſo known.

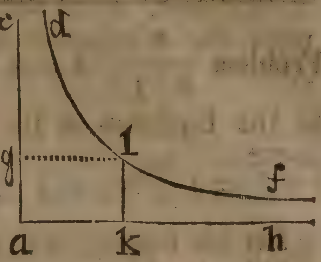
Examp. To find an Hyperbola whoſe Area ſhall be to that of the Apollonian, as 3 to 1. Now the Apollonian is $= \infty \times 1$, ſo $e = 1$, and $p = 3$, *Ergo* the Equation is $y\,x^{\frac{3}{2}} = 1$, whoſe Area by the general Caſe foregoing is $= \infty \times 3$, which is triple of the Apollonian.

Prob. 2. To find an Hyperbola, whoſe interminated Space $HKLF$ ſhall be equal to any given number (a) let $y x^n = 1$ define the Hyperbola ſought, where $n \angle 1$, then $HAGLF = \frac{n}{n-1}$ putting $y = 1$ ($= GL = GA.$) by *Corol.* of § 6. and becauſe $AGLK = 1$, therefore it will be $HAGLF - AGLK (= HKLE) = \frac{n}{n-1} - 1$. Therefore by the condition of the

Problem $\frac{n}{n-1} - 1 = a$. which gives $n = \frac{a+1}{a}$ ſo the Equation to the Hyperbola ſought is $yx^{\frac{a+1}{a}} = 1$.



Let (as before) *AC*, *AH* be the Aſymptotes of any Hyperbola *DLF* defined by this Equation $yx^n = 1$, in which the Abſciſſa $AK = x$, and Ordinate $KL = y$, and n is ſuppos'd either equal to, or greater than Unity. 1° It appears that in all Hyperbola's the interminate Space *CAKLD* is infinite, and the interminate Space *HAGLF* (except in the *Apollonian* where $n = 1$) is finite. 2°. In every Hyperbola, one part of it continually approaches nearer and nearer to the Aſymptote *AC*, and the other part continually nearer to the other Aſymptote *AH*; that is, *LD* meets with *AC* at a Point infinitely diſtant from *A*, and *LF* meets with *AH* at a Point infinitely diſtant from *A*.



3°. In two different Hyperbola's *DLF*, *dlf*, if we ſuppoſe *n* to be greater in the Equation of *dlf* than it is in the Equation of *DLF*, then *LD* ſhall meet ſooner with *AC* than *ld* with *ac*, but *LF* ſhall be longer in meeting with *AH* than *lf* with *ah*. Therefore ſince theſe meetings are at infinite Diſtance from *A* and *a*, it follows neceſſarily that theſe infinite Diſtances muſt be one greater than another, *viz.* $ac \angle AC$, and $ab \urcorner AH$; and in the ſame Hyperbola $AC \angle AH$ and $ac \angle ab$, except the *Apollonian* in which $AC = AH$.

Therefore it muſt needs contribute very much to the right underſtanding the Scope of the foregoing Quadratures of theſe interminate hyperbolick Spaces, if we can determine the Length between the Centre *A* or *a* and the Point of concourſe of either Part of the Hyperbola, with that Aſymptote to which it approaches.

Problem 3. To find the Point *C* where *LD* meets with the Aſymptote *AC*, and the Point *H* where *LF* meets with the Aſymptote *AH*, for any Hyperbola *DLF*, whoſe Equation $yx^n = 1$ is given.

Solution. It is evident that the Ordinates *LK* $\left(= y = \frac{1}{x^n}\right)$ increaſe as the Abſciſſa's *AK* (=

x)

x) decreaſe, ſo the laſt Ordinate muſt co-incide with the Aſymptote *AC*, in which Caſe the Abſciſſa $x = 0 = 1 - 1$. Therefore $AC = \frac{1}{\overline{1-1}|^{n}} = \frac{1}{x_n}$ *Q. E. I.*

Examp. 1. To find *AC* in the common *Hyperbola* $y = \frac{1}{x}$. Becauſe in this $n = 1$, therefore $AC = \frac{1}{1-1} =$ (by *Art.* 1. of § 5) $1 + 1 + 1 + 1$, *&c.* $= \infty \times 1$.

Examp. 2. To find *AC* in the Hyperbola whoſe Equation is $y = \frac{1}{x^2}$. Becauſe in this $n = 2$, therefore from the general Solution $AC = \frac{1}{\overline{1-1}|^{2}} = 1 + 2 + 3 + 4 + 5 + 6$, *&c.* $= \frac{\infty^2}{2}$; That is, *AC* is an infinite Number of equal Parts, each of which is $\infty \frac{1}{2}$: So that *AC* in this is an infinite Number of equal Parts, each of which is $\frac{1}{2}$ *AC* in the common Hyperbola

Schol. If we could give the Preciſe Sum of the Series in *Art.* 3, 4, *&c.* of *Caſe* 1. of § 5. we ſhould then have *AC* for all the other Hyperbola's; but that is not eaſily to be done, as is declared in the Scholium at the End of § 5. Only this much we ſee (by *Caſe* 4. of § 5.) That AC increaſes as the Powers of ∞ whoſe Exponents are n. So in the Hyperbola $y = \frac{1}{x}$, AC is as ∞; In the Hyperbola $y = \frac{1}{x^2}$, AC is as ∞^2; in the Hyperbola $y = \frac{1}{x^3}$, AC is ∞^3; and ſo on

Part. 2*d.* To find AH when LF meets with its Aſymptote AH. Here we muſt conſider GL $(= x)$ as the Ordinate, and AG $(= y)$ as the Abſciſſa. Now when GL becomes AH, then $y = 0$. But univerſally GL $(= x) = \frac{1}{\overline{y}|^{\frac{1}{n}}}$ therefore $AH = \frac{1}{\overline{0}|^{\frac{1}{n}}} = \frac{1}{\overline{1-1}|^{\frac{1}{n}}}$; put $\frac{1}{n} = e$, and then by *Lem.* of § 5. $AH = \frac{1}{\overline{1-1}|^{e}} = 1 + e + \frac{e \times \overline{e+1}}{2} + \frac{e \times \overline{e+1} \times \overline{e+2}}{2 \times 3} + \frac{e \times \overline{e+1} \times \overline{e+2} \times \overline{e+3}}{2 \times 3 \times 4}$, &c.

But ſince we cannot aſſign the Sum of theſe Progreſſions, therefore this Series is of no uſe in the Solution of the Problem. We ſhall therefore conſider the Problem (as to the finding AH) under two Caſes, firſt when n is an Integer, and ſecondly when it is a Fraction.

Caſe 1. When n is an Integer. So if $n = 1$ (as in the common Hyperbola) then AH ($= \frac{1}{1-1} = 1 + 1 + 1$, *&c.* $= \infty \times 1 = AC$. If $n = 2$, then AH ($= \frac{1}{\overline{1-1}|^{\frac{1}{2}}} = \sqrt{\frac{1}{1-1}} = \sqrt{\infty \times 1}$) is a mean Proportional between 1 and Infinite. If $n = 3$, then AH ($= \frac{1}{\overline{1-1}|^{\frac{1}{3}}} = \sqrt[3]{\frac{1}{1-1}} = \sqrt[3]{\infty \times 1}$ is the firſt of two mean Proportionats between 1 and Infinite. And univerſally if between 1 and Infinite there be ſuppoſed as many mean Proportionals as there are Units in $n - 1$, then AH ($= \frac{1}{\overline{1-1}|\frac{1}{n}} = \sqrt[n]{\frac{1}{1-1}} = \sqrt[n]{\infty \times 1}$) ſhall be the firſt of theſe Means.

Caſe 2*d*. When n is a Fraction, ſuppoſe $n = \frac{p}{q}$, but $p \angle q$, becauſe we always ſuppoſe $n \angle 1$ except in the *Apollonian* where $n = 1$. So then $\frac{1}{n} = \frac{q}{p}$, therefore $AH = \frac{1}{\overline{1-1}|^{\frac{p}{q}}} = \sqrt[p]{\frac{1}{1-1}^{q}}$ $= \overline{\infty \times 1}|^{\frac{q}{p}} = \sqrt[p]{\overline{\infty \times 1}|^{q}}$. So for *ex.* if $n = \frac{3}{2}$, *viz.* $p = 3$, $q = 2$, then $AH = \sqrt[3]{\overline{\infty \times 1}|^{2}}$

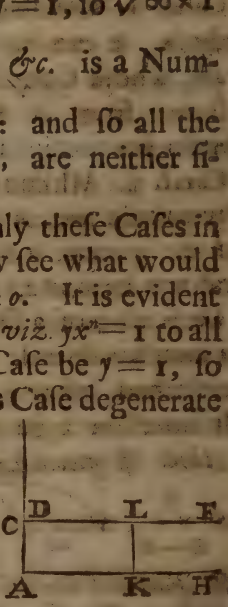
Corol. From both theſe Caſes it is evident, that the greater number we ſuppoſe n to be, ſo much the ſooner will LF meet with AH: for the greater we ſuppoſe n to be, ſo much the leſs will $\frac{1}{n}$ or $(\frac{q}{p})$ be; but $\frac{1}{n}$ (or $\frac{q}{p}$) is the exponent of $\frac{1}{1-1}$ (or ∞) which gives the Value of AH. *Ergo* the greater that n is, the ſhorter will AH be. *Q. E. D.*

Schol. Since in all Hyperbola's $AH = \frac{1}{1-1}^{\frac{1}{n}} = \left.\overline{\frac{1}{1-1}}\right|^{\frac{q}{p}} = \sqrt[p]{\left.\frac{1}{1-1}\right|^{q}} = \sqrt[p]{\left.\overline{\infty \times 1}\right|^{q}}$ is ſome mean Proportional between 1 and $\infty \times 1$, it is worth the while to conſider what ſort of Numbers theſe means are, *viz.* whether they be finite, infinite, or neither. It is certain they cannot be finite, for then it would follow that the Square of a finite number ſhould be infinite, which is abſurd. Nor can they be properly eſteemed Infinite, for the equal part of ſuch an Infinite muſt be 1 divided by ſuch a mean.

Demonſtration. Let a denote that equal part, then $\infty \times a = \sqrt[p]{\left.\overline{\infty}\right|^{q}}$, which gives $a = \frac{1}{\sqrt[p]{\left.\overline{\infty}\right|^{p-q}}}$ *Q. E. D.* *Ex. gra.* $\sqrt{\infty \times 1}$ or a mean between 1 and infinite muſt be $\infty \times \frac{1}{\sqrt{\infty}}$ or an infinite

Number of equal Parts, each of which is $\frac{1}{\sqrt{\infty}}$ or 1 divided by the mean between 1 and $\infty \times 1$. So that this equal part $\frac{1}{\sqrt{\infty \times 1}}$ is neither finite, nor infinitely ſmall, nor infinitely great, and conſequently the mean $\sqrt{\infty \times 1}$ is not properly an infinite Number. And hence we ſee that there are Progreſſions of Numbers whoſe Sums are neither finite nor infinite, but between both. *Ex. gra.* $\sqrt{\infty \times 1}$ where $p = 2$, $q = 1$, ſo $\sqrt{\infty \times 1}$ $\frac{1}{\overline{1-1}|^{\frac{1}{2}}} = 1 + \frac{1}{2} + \frac{3}{8} + \frac{5}{16} + \frac{35}{128}$ *&c.* is a Number neither finite nor infinite: and ſo all the means between 1 and Infinite, are neither finite nor infinite.

I have hitherto conſidered only theſe Caſes in in which $n =$ or $\angle\ 1$; let us now ſee what would be the Reſult if we ſuppoſe $n = o$. It is evident then that the general Equation, *viz.* $yx^n = 1$ to all Hyperbola's would, in, this Caſe be $y = 1$, ſo that the Hyperbola's will in this Caſe degenerate into a ſtrait Line *D L F*, parallel to *A H*. But conſidering it as the ſimpleſt Hyperbola, let us conſider at what diſtance it will meet with its Aſymptotes. Now univerſally $AC = \frac{1}{x|^n}$ (by the *Sol*



when

of part. 1. of *Prob.* 3.) when $x = 0$, but $n = 0$ by Suppoſition: *Ergo*, be x, what it will $x^0 = 1$, *Ergo*, $AC = 1$, 2°. From the Solution of part 2. of *Prob.* 3. we have found that $AH = \frac{1}{\overline{1-1}|^{\frac{1}{n}}}$ which in this Caſe will give $AH =$

$$\frac{1}{\overline{1-1}|^{\frac{1}{0}}} = \frac{1}{\overline{1-1}|^{\frac{1}{1-1}}},$$ that is $AH = \overline{\infty}|^{\infty}$ or the infinite Power of infinite.

Corol. 1. Conſidering a ſtrait Line as an Hyperbola, it can have but one Aſymptote, *viz.* AH, whoſe Concurſe with AH is at greater Diſtance from A than any other Hyperbola whatſoever.

Corol. 2. All the Hyperbola's $yx^n = 1$ whoſe Aſymptotes are AC, AH muſt interſect DF; and the greater n is, ſo much the more they bend towards AH and recede from DF. And as they all interſect DF, ſo they all interſect one another in one point only; and after the Interſection, that in which n is greateſt, ſtill falls loweſt or approaches neareſt to AH.

Schol. If you ſuppoſe n infinitely great, *viz.* $n = \frac{1}{1-1}$, then the Hyperbola will be a ſtrait Line parallel to the Aſymptote AC.

Sect. 7. We have now finiſhed this Buſineſs of the Hyperbola's which has afforded us a new Speculation of Numbers, *viz.* of ſuch as are

neither

neither finite nor infinite, which deſerves to be conſider'd better than either my Time or my Capacity will permit. However I ſhall here ſet down a few thoughts about them, till I have more Leiſure to proſecute them.

Firſt then, to diſtinguiſh them from finite and infinite, I ſhall call them *indefinite* Numbers, and denote them by this Sign $\propto$.

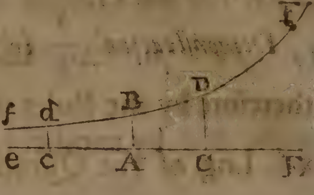
2°. *Indefinite* Numbers I ſuppoſe to be intermediate Numbers lying between finite and infinite: For as we do not deſcend from 1 to 0 at one Step, but muſt paſs through an infinite Series of Fractions, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, *&c.* So it is impoſſible that in aſcending from 1 to ∞, we ſhould paſs immediately from finite to infinite; therefore the Steps between theſe two are indefinite Numbers: thus before we artive from 1 to ∞ 1, we muſt come at $\surd \infty$ 1, and before we come at $\sqrt{\infty \times 1}$ we muſt firſt come at $\sqrt[3]{\infty \times 1}$ and ſo on.

3°. The Rules for the Arithmetick of Indefinites, may be made after the ſame manner as is done for that of Infinites by D. *Cheyne.* To which I ſhall add, that an Indefinite as $\infty \frac{q}{p}$ or $\sqrt[p]{\overline{\infty}|^{q}}$ multiplied by another Indefinite as $\overline{\infty}|^{\frac{r}{s}}$ makes the Product $\overline{\infty}|^{\frac{q}{p}+\frac{r}{s}}$ this Product becomes Infinite when it happens that $qs + pr \angle$ or $= ps$, but the Product is only Indefinite when $qs + pr \urcorner ps$. And if an Indefinite as $\overline{\infty}|\frac{q}{p}$ be divided by another Indefinite as $\overline{\infty\frac{r}{s}}$, the Quotient $\overline{\infty}|\frac{p}{q} - \frac{r}{s}$ is infinite when $qs - pr$ is $\angle$ or $= ps$; but it is finite when $qs - pr = 0$, and indefinite when $qs - pr \urcorner ps$.

Note, That in expreſſing an Indefinite Number by $\overline{\infty}\frac{p}{q}$, I always ſuppoſe the Numerator q leſs than the Denominator p; for if q be either $\angle$ or $= p$, then $\overline{\infty}|\frac{p}{q}$ is an Infinite. That theſe Numbers are not infinite, may be thus demonſtrated. If (*ex. gr.*) $\sqrt{\infty \times 1}$ were infinite, then $\infty \times \frac{1}{\sqrt{\infty}} \left(= \sqrt{\infty \times 1}\right)$ muſt be infinite, and alſo $\frac{1}{\sqrt{\infty}}$ muſt be $= 0$; *Ergo* $\infty \times 0 = \infty \times \frac{1}{\sqrt{\infty}} \left(= \sqrt{\infty}\right) =$ infinite, but $\infty \times 0 = 1$; *Ergo* $1 =$ infinite, which is abſurd.

Sect. 8. Containing ſome miſcellaneous things relating to Infinites.

Lem. Let *F B D d e* be a Logarithmick Curve whoſe firſt Ordinate $AB = 1$, Abſciſſa $AC = x$, Ordinate $CD = y$, and Aſymptote *E e*:



Now from the known Property of this Curve, it Follows,

1°. That *A C* are the Logarithms of *C D*, *i. e.* If you make the Ordinate $y = CD$ repreſent a Number, then its Abſciſſa x ($= AC$) ſhall be the Logarithm thereof.

2°. That the Logarithm of 1 is nothing; for the firſt Ordinate $AB = 1$, but its Abſciſſa is $= 0$, therefore (by 1°) the Log. of $1 = 0$.

3°. That the Ordinates *c d* (to the left of *A B*) denoting Fractions, their reſpective Abſciſſa's *A c* are the Logarithms of theſe Fractions: So that as x is the Log. of any Integer, *C D*, in the like manner $-x$ denotes the Log. of any Fraction (*c d*).

4°. That the Log. of any Fraction $\frac{1}{n}$ is equal to — Log. of n. So that the Log. of any Fraction (whoſe Numerator is 1) is equal in Magnitude to the Log. of that whole Number, which is the Denominator; there being no Difference between the Log. of that Fraction $\frac{1}{n}$ and the Log. of this Integer n, but that this is $+x$ (becauſe it lies to the right from *A* towards *E*)

E) and the other $-x$ becauſe it lies to the left from *A* towards *e*.

Demonſtration. $\frac{1}{n}$ ſignifies 1 divided by *n*, therefore by the Rules of Diviſion $l:1-l:n=$ Log. of the Quotient, *viz.* $l:\frac{1}{n}$. But $l:1=0$ (by 2°) *Ergo* $-l:n=l:\frac{1}{n}$. *Q. E. D.*

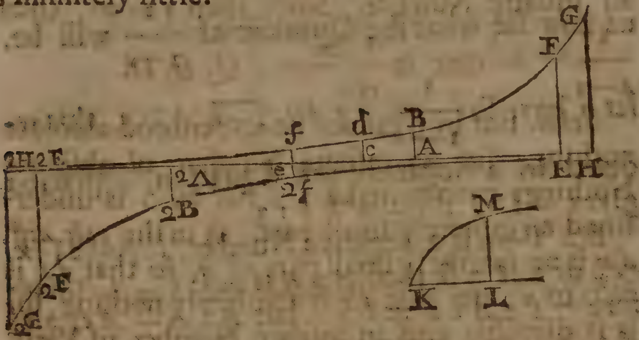
5°. If this Curve be continued (*utrinque*) from *B in infinitum*, then *f* will meet with the Aſymptote at an infinite Diſtance *A e*: But it will diverge from the Aſymptote on the other ſide, ſo that at an infinite Diſtance *A E* the laſt Ordinate *E F* will be infinite. And ſince the laſt Ordinate *e f* is $=0$, whoſe Abſciſſa $A\,e=\infty$, it is evident that the Log. of 0 is $=\infty$ or rather $=-\infty$; It is evident likewiſe the laſt Ordinate *E F* is $=\infty$, whoſe Abſciſſa *A E* is alſo $=\infty$. So that the Log of 0 and the Log. of ∞ are equal, only the one is $+\infty$ and the other $-\infty$.

Prop. 1. $\frac{1}{a}=\infty=1+1+1+1+1$, *&c.* This may ſeem abſurd, but the Demonſtration is evident from the foregoing *Lemma*. For $\frac{1}{1-1}=\frac{1}{0}$. Let then $\frac{1}{1-1}=y$. That is $\overline{1-1}|^{-1}=y$.

This reduc'd to a logarithmical Equation gives $-1 \times l : \overline{1-1} = l : y$; that is $-1 \times l : 0 = l : y$, But $l : 0 = -\infty$ (by *Art.* 5. of the *Lem.*) *Ergo* $-1 \times -\infty\, l : y$, that is $+\infty = l : y$. Therefore y is infinite (*ſc.* $y = \infty$) for no Number has an affirmative and infinite Logarithm, except an infinite Number. Since then $y = \infty$, then $\frac{1}{1-1} = \infty$ that is $\frac{1}{0} = \infty$. *Q. E. D.*

Schol. But by 0 cannot be underſtood abſolute nothing, for an infinite Number of abſolute Nothings cannot make 1: but by 0 is underſtood an infinitely ſmall part, as in the *calc. diff.* dx is an infinitely ſmall part of x, ſo that dx is as 0 to x: not that dx is abſolutely nothing, for it is diviſible into an infinite Number of Parts, each of which is ddx. And therefore the Demonſtration, which ſuppoſing f and e meeting at an infinite Diſtance Ae, makes the laſt Ordinate $ef = 0$, implies no more but that $ef = dx$. But then it may be inquir'd what is the Quotient that ariſes from the Diviſion of 1 by abſolute Nothing. I ſay there is no Quotient becauſe there is no Diviſion: therefore it is a Miſtake to ſay the Quotient is 1 or Unity undivided, which is demonſtrably falſe, neither is the Quotient $= 0$. For properly ſpeaking there is no Quotient, and therefore it is an Error to aſſign any. In like manner, it is an Errot to ſay that $0 \times a$ makes the Product 0; for properly ſpeaking there is no Product. It is true, this of Multiplication has no influence upon Practice, but that of Diviſion has.

From hence it appears, that a Curve is ſaid to meet with its Aſymptote, when the Ordinate is infinitely little.



This ſame Notion does explain how it comes to paſs that 1 divided by a negative Number, gives a Quotient greater than infinite. For if (when you call $LM = x$, $KL = y$.) $fe = dx$, then becauſe the Points f and e are infinitely near, we may conceive the Logarithmick Curve continued as interſecting AH in the Point e; ſo that $FBf\,2f\,2B\,2F\,2G$ makes but one continued Curve, whereof the Part above repreſents the affirmative Numbers by its Ordinates, and the negative Numbers are repreſented by the Ordinates of the Part below; but A is the Beginning of the Axis for the Logarithms of both, *viz.* AE, AH, *&c.* are the Logarithms of the affirmative Integers FE, GH, *&c.* Ac the

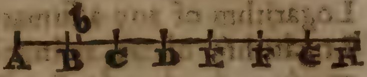
Logarithm of any affirmative Fraction, Ae the Logarithm of an infinitely little Fraction $fe = dx$. $A2A$, $A2E$, &c. The Logarithms of the negative Numbers, $2A\,2B$, $2E\,2F$, &c.

Now let n be any Number greater than Unity, then $1-n$ will be a negative Number, let us now ſee what the Quotient of $\frac{1}{1-n}$ will be, let it be y, ſo $\frac{1}{1-n} = y$ *i.e.* $\overline{1-n}|^{-1} = y$, this reduc'd to a logarithmick Equation, Equation gives $-1 \times l : 1-n = l : y$.

But $1-n$ is a negative Number, ſuppoſe (*ex. gr.*) of $2A\,2B$ then $A2A$ is $= l : 1-n$, therefore $-1 \times A2A = l.\,y.$ but $A2A \angle Ae$, and $Ae = -\infty$, therefore $A2\,A \angle -\infty$. Let then $A2A = -\infty \times a$ (where $a \angle 1$) then $-1 \times -\infty\, a = l : y$, that is $\infty \times a = l : y$, but $\infty \times a \angle \infty$, *Ergo* y is a Number greater than infinite.

And here it is obſervable that there are affirmative Numbers leſs than nothing, denoted by the ſeveral Powers of dx, as dx^2, dx^3, &c. or by the ſecond, third, &c. Differences, and theſe Numbers may be aptly repreſented by the Ordinates of the Logarithmick Curve, continued from f towards $2H$ when dx^n, is affirmative, or from $2f$ towards H when dx^n is negative.

Another way of explaining what is meant by $\frac{1}{0} = \infty$.



Let *A H* produced indefinitely be divided into equal Parts *AB*, *BC*, *CD*, *DE*, *&c.* ſo that a Part of this Line ſhall denote any Number, ſuppoſing $AB = 1$, let then x denote any Number, *ex. gr.* let $x = AB$ and $y = Ab$. ſo $\frac{1}{y-x} = \frac{1}{y} + \frac{x}{y^2} + \frac{x^2}{y^3} + \frac{x^3}{y^4} + \frac{x^4}{y^5}$, *&c.*

Now ſuppoſe *b* infinitely near to *B*, then $y - x = Bb = dx$, ſo that $\frac{1}{y-x} = \frac{1}{dx}$. But $x = dx + dx + dx$, *&c.* That is $1 \times x = dx \times 1 + 1 + 1 + 1$, *&c.* And therefore $\frac{1}{dx} = \frac{1}{x} + \frac{1}{x} + \frac{1}{x} + \frac{1}{x}$, *&c.* But by Suppoſition $x = AB = 1$. *Ergo* $\frac{1}{dx} = 1 + 1 + 1 + 1$, *&c.* $= \infty \times 1$ But $\frac{1}{0} = 1 + 1 + 1 + 1$, *&c.* *Ergo* $\frac{1}{0} = \frac{1}{dx}$, or $dx = 0$, but dx is not abſolute nothing, and therefore when we ſay $\frac{1}{0} = 1 + 1 + 1$, *&c.* 0 does not denote abſolute nothing, but only dx or an infinitely ſmall part of x. And therefore

fore when (in the Quotient $\frac{1}{y-x}$) we ſay let $y=x$, the meaning is not that y is abſolutely equal to x, (for then there would be no Diviſion, and conſequently no Quotient) but only that y exceeds x by an infinitely ſmall Quantity dx, which is ſufficient to make them equal.

I have hitherto conſidered no Progreſſions of Numbers except theſe that are in Arithmetical and Geometrical Progreſſions, and theſe that ariſe from $\frac{1}{\overline{1-1}|^{e}}$ as in § 5. I ſhall now proceed to treat of other Progreſſions, and theſe which offer themſelves firſt are the ſeveral powers of Numbers in an Arithmetical Progreſſion. Let then z denote the Sum of any Arithmetical Progreſſion a, $a+x$, $a+2x$, $a+3x$, $a+4x$, *&c.* A the Sum of their Squares, B the Sum of their Cubes, C the Sum of their Biquadrates, *&c.* that is, let

$$z=a+(a+x)+(a+2x)+(a+3x)+(a+4x)\ \&c.$$

$$A=a^{2}+\overline{a+x}|^{2}+\overline{a+2x}|^{2}+\overline{a+3x}|^{2}+\overline{a+4x}|^{2}\ \&c.$$

$$B=a^{3}+\overline{a+x}|^{3}+\overline{a+2x}|^{3}+\overline{a+3x}|^{3}+\overline{a+4x}|^{3}\ \&c.$$

$$C=a^{4}+\overline{a+x}|^{4}+\overline{a+2x}|^{4}+\overline{a+3x}|^{4}+\overline{a+4x}|^{4}\ \&c.$$

And ſo on to higher Powers. Now in order to find the Sum of any of theſe Progreſſions aſcending till the laſt Term is $= \infty \times 1$, I ſhall premiſe theſe following *Lemma*'s, by the help whereof you may find z, A, B, C, *&c.* for any number of Terms. Calling therefore t the number of Terms in each Series, and v the laſt Term of the firſt whoſe Sum is z. I ſay

$$\textit{Lem. 1.}\quad z = \frac{v^2 + xv + ax - a^2}{2x}$$

$$\textit{Lem. 2.}\quad A = \frac{\overline{v+x}|^3 - a^3 - tx^3 - 3x^2 z}{3x}$$

$$\textit{Lem. 3.}\quad B = \frac{\overline{v+x}|^4 - a^4 - tx^4 - 4x^3 z - 6x^2 A}{4x}$$

$$\textit{Lem. 4.}\quad C = \frac{\overline{v+x}|^5 - a^5 - tx^5 - 5x^4 z - 10x^3 A - 10x^2 B}{5x}$$

In each of which $tx = v + x - a$ (by *Lem.* 1. § 1.) and it is eaſy to continue theſe *Lemma*'s for higher Powers.

Before we apply theſe *Lemma*'s to the finding the Sum of any Progreſſion whoſe laſt Term is infinite, it will be neceſſary to ſubſtitute the values of t, z, A, B, C, *&c.* When you have made this Subſtitution, you muſt reject out of the *Lemma*'s every Term in which v does not occur; for the laſt Term being infinite, will make v an indefinite Number, and ſince all the other Terms (in which v is not) are finite, therefore they are as nothing in reſpect of v and conſequently to be rejected. So, for Progreſſions whoſe laſt Term is $= \infty$, the *Lemma*'s will be

Lem. 1. $z = \frac{v^2 + xv}{2x}$

Lem. 2. $A = \frac{v^3 - x^2 v}{3x} - \frac{v^2 - xv}{2}$.

Lem. 3. $B = \frac{v^4 - 2xv^3 + x^2 v^2 + 2x^3 v}{4x}$

Lem. 4. $C = \frac{v^5}{5x} + \frac{15v^4 + 10xv^3 - 59x^3 v}{30}$

Let us now conſider what the value of v is, in each of the *Lemma*'s *A*, *B*, *C*, *&c.* An example or two will make the thing plain.

Ex. 1. Let 1, 2, 3, 4, 5, *&c.* to v, whoſe Sum is z.
Then for *Lem.* 2. 1, 4, 9, 16, 25, *&c.* to v^2, whoſe Sum is *A*.

But $v^2 = \infty$ (by *Supp.*) Therefore $v = \sqrt{\infty} = \overline{\infty}|^{\frac{1}{2}}$ ſo that $\infty^{\frac{1}{2}}$ is the value of v in *Lem.* 2*d.* In like manner $\sqrt[3]{\infty}$ or $\infty^{\frac{1}{3}}$ is the value of v in *Lem.* 3. And univerſally if e denote the Exponent of the Power to which each of the Terms of any Arithmetical Progreſſion are raiſed, then $v = \sqrt[e]{\infty} = \overline{\infty}|^{\frac{1}{e}}$. in the *Lemma* that gives the Sum of theſe Terms (whoſe laſt is ∞) raiſed to this Power.

Prop. 1. To find the Sum of a Series of Numbers (continued till the laſt Term is ∞) whoſe Terms are the Squares of any Arithmetical Progreſſion.

By *Lem.* 2. the Sum ſought is $A = \frac{v^3 - x^2 v}{3x} - \frac{v^2 - xv}{2}$; but in this Caſe $v = \sqrt{\infty}$ or $\infty^{\frac{1}{2}}$, therefore all the Terms except the higheſt muſt evaniſh, and conſequently the Sum of the Squares $A = \frac{v^3}{3x} = \frac{\overline{\infty^{\frac{1}{2}}}|^3}{3x} = \frac{\infty^{\frac{3}{2}}}{3x} = \infty \times \frac{\infty^{\frac{1}{2}}}{3x}$,

Examp. Let x be $= 1$, ſo 1, 2, 3, 4, &c. to $\sqrt{\infty}$ is the Arithmetical Progreſſion, the Sum (A) of whoſe Squares is ſought; I ſay $1 + 4 + 9 + 16$ &c. $\infty \times \frac{1}{3}\sqrt{\infty}$ that is, the Sum of the Progreſſion is an infinite Number of equal Parts, each of which is $\frac{1}{3}\sqrt{\infty}$.

Prop. 2. To find the Sum of the Cubes of any Arithmetical Progreſſion.

In this Caſe $v = \sqrt[3]{\infty}$ or $\infty^{\frac{1}{3}}$. Therefore in *Lem.* 3*d.* all the Terms except the higheſt muſt evaniſh, ſo that $B = \frac{v^4}{4x} = \frac{1}{4x}\overline{\infty^{\frac{1}{3}}}|^4 = \frac{\infty^{\frac{4}{3}}}{4x} = \infty \times \frac{\infty^{\frac{1}{3}}}{4x}$.

Ex. Let $x = 1$, ſo 1, 2, 3, 4, 5, &c. to $\sqrt[3]{\infty}$ is the Arithmetical Progreſſion, the Sum (B) of whoſe Cubes is ſought, I ſay $1 + 8 + 27 + 64 + 125$ &c. $= \infty \times \frac{\infty^{\frac{1}{3}}}{3}$.

Prop. 3. To find the Sum of the Biquadrates of any Arithmetical Progreſſion.

In this Caſe $v = \sqrt[4]{\infty}$ or $\infty^{\frac{1}{4}}$. Therefore by *Lemma* 3*d.* $C = \frac{v^5}{5x} = \frac{1}{5x} \overline{\infty^{\frac{1}{4}}}|^5 = \frac{1}{5x} \infty^{\frac{5}{4}} = \infty \times \frac{\infty^{\frac{1}{4}}}{5x}$.

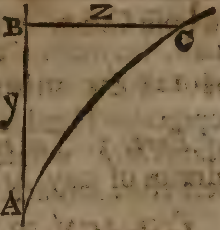
Ex. Let $x = 1$, ſo 1, 2, 3, 4, &c. to $\sqrt[4]{\infty}$ is the Arithmetical Progreſſion, I ſay then that $1 + 16 + 82 + 256$ &c. $= \infty \times \frac{\infty^{\frac{1}{4}}}{5}$.

Prop. 4. *Univerſal.* Let e denote the Exponent of any Power, to which the Terms of any Arithmetical Progreſſion $a.\ a + x.\ a + 2x.\ a + 3x$, &c. are raiſed, and it is required to find the Sum of the Terms ſo raiſed. I ſay

$$a^e + \overline{a + x}|^e + \overline{a + 2x}|^e + \overline{a + 3x}|^e + \overline{a + 4x}|^e \text{ \&c.} = \infty \times \frac{\infty^{\frac{1}{e}}}{\overline{e + 1} \times x}.$$

Scholium. From hence may be eaſily deduc'd the Quadratures of all the Parabola's $z = y^e$

where z is the Ordinate, y the Abſciſſa, and e an affirmative Number) which is one remarkable uſe of this Arithmetick of Infinites. For if in this Figure $AB = y$, $BC = z$, and $z = y^e$ it is plain that if you put $y = 1, 2, 3, 4, 5,$ *&c.* ſucceſſively, then will $z = 1^e, 2^e, 3^e, 4^e,$ *&c.* ſucceſſively: which ſhews that the Ordinates are the Terms of an Arithmetical Progreſſion rais'd to a Power, whoſe Exponent is e, and that (x) the common Difference is 1; But if the firſt Abſciſſa $y = 1$ be infinitely (or indefinitely ſmall) then the Ordinates will be infinitely near to one another, and the laſt Ordinate BC will be an ∞ Number of theſe Ones. Therefore ſince to find the Area ABC, is, in effect, to find the Sum of the Ordinates, and ſince the Ordinates are $1^e, 2^e, 3^e, 4^e, 5^e,$ *&c.* till you come to the laſt which is $BC = \infty$. Therefore by Prop. 4. $ABC = \infty \times \frac{\infty^{\frac{1}{e}}}{e+1}$, that is $ABC = BC \times \frac{\overline{BC}|^{\frac{1}{e}}}{e+1}$, the ſame which is found by the ordinary Methods of Quadratures. And note that the whole Abſciſſa AB denotes the Number of the Terms.



N. B. *The Quadrature of all ſorts of Curves, expreſs'd by one Term thus aſſign'd, it is eaſy by the Method of Aſſumptions of Series's to extend this Method to all Sorts of Quadratures hitherto diſcovered.*

ADDITIONS.

I have ſhewn in *p.* 160. *&c.* that mean Proportionals, between 1 and ∞ are neither finite nor infinite. For a farther illuſtration of what I have ſaid upon this Head let us conſider what theſe Progreſſions are, whoſe Sum is more than finite and leſs than infinite.

Prop. 1. $\sqrt{\infty}$ is a mean between 1 and infinite; but $\infty = \frac{1}{1-1}$, therefore $\sqrt{\infty} = \frac{1}{\sqrt{1-1}} = \overline{1-1}|^{\frac{1}{2}}$ which by Sir *Iſaac Newton*'s Theorem gives

$$\sqrt{\infty} = \overline{1-1}|^{-\frac{1}{2}} = 1 + \tfrac{1}{2} + \frac{1\times3}{2\times4} + \frac{1\times3\times5}{2\times4\times6} + \frac{1\times3\times5\times7}{2\times4\times6\times8},\ \&c.$$

that is $\sqrt{1+1+1,\ \&c.}$

$$= 1 + \tfrac{1}{2} + \frac{1\times3}{2\times4} + \frac{1\times3\times5}{2\times4\times6} + \frac{1\times3\times5\times7}{2\times4\times6\times8}\ \&c.$$

And ſo (by ſquaring each ſide of this Equation) you will find it in Fact to be $1+1+1$, *&c.* $= 1+1+1$, *&c.* From hence it appears that the Progreſſion, whoſe Sum (being neither finite nor infinite) is $\sqrt{\infty}$ conſiſts of Fractions whoſe Numerators are the Products of the continual Multiplication of the Arithmetical Progreſſion 1, 1, 3, 5, 7, 9, &c. and the Denominators are the Products of the Multiplications of the Terms of this Arithmetical Progreſſion 2, 4, 6, 8, 10 &c.

Corol. In like manner you may find $\sqrt[3]{\infty}$, $\sqrt[5]{\infty}$ &c. by reſolving $\frac{1}{\sqrt[3]{1-1}} = \overline{1-1}|^{-\frac{1}{3}}$, $\frac{1}{\sqrt[5]{1-1}} = \overline{1-1}|^{-\frac{1}{5}}$ &c. into a Series by Sir *Iſaac Newton*'s Theorems. So

$$\sqrt[3]{\infty} = \frac{1}{\sqrt[3]{1-1}} = \overline{1-1}|^{-\frac{1}{3}} = 1 + \tfrac{1}{3} + \frac{1\times4}{3\times6} + \frac{1\times4\times7}{3\times6\times9}$$

&c. where the Numerators and Denominators are in Arithmetical Progreſſions, whoſe common difference is 3.

$$\sqrt[5]{\infty} = \frac{1}{\sqrt[5]{1-1}} = \overline{1-1}|^{-\frac{1}{5}} = 1 + \tfrac{1}{5} + \frac{1\times6}{5\times10} + \frac{1\times6\times11}{5\times10\times15}$$

&c. $\sqrt[e]{\infty} = \frac{1}{\sqrt[e]{1-1}} = \overline{1-1}|^{-\frac{1}{e}}$

$$\tfrac{1}{e} = 1 + \frac{1}{e} + \frac{1\times\overline{e+1}}{e\times2e} + \frac{1\times\overline{e+1}\times\overline{2e+1}}{e\times2e\times3e} + \frac{1\times\overline{e+1}\times\overline{2e+1}\times\overline{3e+1}}{e\times2e\times3e\times4e} + \frac{1\times\overline{e+1}\times\overline{2e+1}\times\overline{3e+1}\times\overline{4e+1}}{e\times2e\times3e\times4e\times5e}$$

&c.

Prop. 2. Let 1 be the firſt, r the ſecond, and v the laſt Term of a Geometrical Progreſſion $1, r, r^2, r^3, r^4,$ *&c.* and t the number of Terms, then $v = r^{t-1} = \frac{r^t}{r}$, which gives $r^t = r v$.

Corol. Let τ be the number of Terms, and v the laſt Term in the like Progreſſion $1, s, s^2, s^3, s^4$ *&c.* then $v = \overline{s}|^{\tau-1}$.

Corol. 2. From theſe two Values of v, I have this Equation $r^{t-1} = s^{\tau-1}$; whence it appears that if s be greater than r, then will $\tau \angle t$, that is, In any two Progreſſions whoſe firſt Terms are the ſame, that whoſe ſecond Term s is greater than r the ſecond Term of the other, will ſooner arrive at any given number v.

Example. Let $r = 2$, then $1, 2, 4, 8, 16$. Let $s = 4$, then $1, 4, 16$. that is, there are 5 Terms (or $t = 5$) in arriving at 16 in the firſt Progreſſion, whereas in the ſecond ($\tau = 3$) it arrives at 16 in the 3*d* Term.

Problem Having $r, t, s,$ to find τ in which they ſhall both have the ſame laſt Term v.

Sol. $s^{\tau-1} = r^{t-1}$ (by *Corol.* 2.) this turn'd into a logarithmical Equation is $\overline{\tau - 1} \times l s = \overline{t - 1} \times l r$, which reduced gives $\tau = \frac{t l r + l s - l r}{l s} = \frac{t l r - l r}{l s} + 1$. *Q. E. I.*

Corol. Becauſe by *Prop.* 2. $r^t = r v$, therefore $t l r = l r v$, ſo ſubſtituting $l r v$ in place of $t\,l\,r$, we ſhall have $\tau = \frac{l\,r\,v - l\,r + l\,s}{l\,s} = \frac{l\,r\,v}{l\,s} - \frac{l\,r}{l\,s} + 1.$

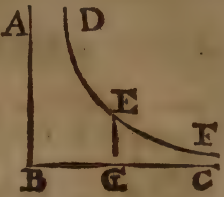
Corol. 2. Becauſe by *Corol.* 1. $t\,l\,r = l\,r\,v$, therefore $t = \frac{l\,r\,v}{l\,r}$. And conſequently

$$t - \tau = \frac{l\,r\,v}{l\,r} - \frac{l\,r\,v}{l\,s} + \frac{l\,r}{l\,s} - 1.$$

But by the known property of Numbers we have $l\,r + l\,v = l\,r\,v$, therefore $t - \tau = \frac{l\,r + l\,v}{l\,r} - \frac{l\,r - l\,v}{l\,s} + \frac{l\,r}{l\,s} - 1$ that is $t - \tau = 1 + \frac{l\,v}{l\,r} - \frac{l\,v}{l\,s} - 1$, that is,

$$t - \tau = \frac{l\,v}{l\,r} - \frac{l\,v}{l\,s}.$$

Corol. 3. Let the laſt Term v be infinite or ∞, then $t - \tau = \frac{l:\infty}{l\,r} - \frac{l:\infty}{l\,s}$; which ſhews how much ſooner the Progreſſion 1, s, s^2, s^3, *&c.* will arrive at ∞, than 1, r, r^2, r^3, *&c.* that is, how many more Terms there is in 1, r, r^2, r^3, *&c.* than in 1, s, s^2 s^3, *&c.* when the laſt in both is ∞.



Prop. 3. Let $BG=x$ $GE=y$; $yx^{s}=1$, where s is any number greater than Unity. Then by the *Calculus Integralis*, we have $DEGBA=\frac{\overline{x|}^{\,1-s}}{1-s}$, ſo putting $x=1$, we have $DEGBA=\frac{1}{1-s}$.

But $\frac{1}{1-s}=1+s+s^{2}+s^{3}+s^{4}$ &c. $=DEGBA$.

But calling v the laſt Term of this aſcending Geometrical Progreſſion $1+s+s^{2}+s^{3}+$ &c. we ſhall (as is ſhewn in Page 136. of this Chapter) have $1+s+s^{2}+s^{3}+s^{4}+$ &c. $=\frac{sv}{s-1}$, therefore $DEGBA=\frac{sv}{s-1}$. So that we have three different expreſſions of the Area $DEGBA$, *viz.* $\frac{1}{1-s}$, $\frac{sv}{s-1}$, and the Series $1+s+s^{2}+s^{3}+s^{4}$ &c.

But what this number v is (which denotes the laſt Term of the Progreſſion $1+s+s^{2}+s^{3}$ &c.) is not ſo eaſy to determine; certainly it cannot be $v=\infty\times 1$ or $1+1+1$ &c. For then

$DEGBA = \infty \times \frac{s}{s-1}$; therefore if in one Hyperbola we put $s = 2$, (*ſcil.* $yx^2 = 1$) we have $DEGBA = \infty \times 2$; and putting in another $s = 3$ (*ſcil* $yx^3 = 1$) we have $DGEBA = \infty \times \frac{3}{2}$; now this would make the Area of the Hyperbola $yx^2 = 1$ *ſcil.* $\infty \times 2$ greater than the Area of the Hyperbola $yv^3 = 1$ *ſcil.* $\infty \times \frac{3}{2}$ (becauſe $2 \angle \frac{3}{2}$) but it is eaſy to Demonſtrate, that in the Hyperbola's $yx^s = 1$, the greater we ſuppoſe the Exponent s, ſo ſhall the Area $DEGBA$ (adjacent to BG) be the greater, and conſequently the laſt Term v of the ſeries $1 + s + s^2 + s^3$ *&c.* cannot be ∞ or $1 + 1 + 1 + 1 + 1$ *&c.* for upon that value of v, the expreſſion $\frac{sv}{s-1}$ would make the Area $DEGBA$ to decreaſe as s did increaſe.

To diſcover the value of v, we have $DGEBA = \frac{sv}{s-1} = \frac{1}{1-s}$; which gives $v = \frac{s-1}{s-s^2} = \frac{s-1}{s} \times \frac{1}{1-s} = \frac{1}{-s}$.

Having found $v = \frac{1}{-s}$, we ſee that in two different Hyperbola's (*Ex gr* $yx^2 = 1$, and $yx^3 = 1$,) v cannot have the ſame value, for in the former $v = \frac{1}{-2}$, which is leſs then $v = \frac{1}{-3}$, in the other.

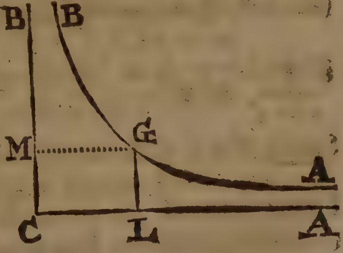
Secondly. From the value of $v = \frac{s-1}{s} \times \frac{1}{1-s}$ we ſee that the laſt Term v is equal to the Sum of the Series (*viz.* $1+s+s^2+s^3$ *&c*) multiplied upon $\frac{s-1}{s}$ for $\frac{1}{1-s}$ is $= 1+s+s^2+s^3$ &c.

Corol. I ſay the laſt Term v cannot be $\infty \times n$, take what number you will for n (except in the Caſe of the common Hyperbola, where $s=1$) For if it were poſſible, let $v = \infty \times n$; then muſt $\frac{s-1}{s-s^2} = \infty \times n$, therefore $s-1 = \infty \times ns - ns^2$, which gives $1 = \infty \times \frac{ns-ns^2}{s-1}$, and conſequently $\frac{1}{\infty} = \frac{ns-ns^2}{s-1}$, but $\frac{1}{\infty} = 0$, therefore $\frac{ns-ns^2}{s-1} = 0$, which gives $s=1$. *Q. E. D.*

Corol. 2. It is evident that v is ſome power of s, let the Exponent of that Power be n, *ſcil.* $v = s^n$, but $\frac{sv}{s-1} = \frac{1}{1-s}$, therefore $\frac{s \times s^n}{s-1} = \frac{1}{1-s}$, *id eſt*, $\frac{s^n+1}{s-1} = \frac{1}{1-s}$, therefore $s^{n+1} = \overline{s-1} \times \frac{1}{1-s}$, which reduced to a Logarithmick Equation gives $\overline{n+1} \times l:s = l:\overline{s-1} + l:\frac{1}{1-s}$: which gives $n = \frac{l:\overline{s-1} + l:\frac{1}{1-s}}{l:s} - 1$. *Q E I.*

An ANSWER *to* Mr. Varignon's *Reflections upon Spaces greater than infinite.*

LET BC, AC making a right Angle at C be the Aſymptotes of any Hyperbola BGA; the Abſciſſe $CL = x$, and Ordinate $LG = y$; and the general Equation to all Hyperbola's $yx^e = 1$. Then becauſe $y = \frac{1}{x^e} = x^{-e}$, we have $ydx = x^{-e}dx$, therefore $\int : ydx = \int : x^{-e}dx$; but by the Calculus Integralis $\int : x^{-e}dx = \frac{x^{1-e}}{1-e}$, therefore $\int : ydx = \frac{x^{-e}}{1-e}$; But $\int : ydx = BGLCB$, therefore $\frac{x^{1-e}}{1-e} = BGLCB$;



This Concluſion (though deduced naturally from Principles which Mr. *Varignon* acknowledges to be true) he denies, aſſuring us that it is only the Negative Expreſſion of the Area $AGLA$ or Complement of $BGLCB$, when $e \angle 1$ But (without any regard to the Ratio of e to 1, le us conſider the Algebraical Expreſſions of theſe two Spaces *BGLCB* and *AGLA*; we have already found $BGLCB = \frac{x^{-e}}{1-e}$; and calling the Abſciſſe $CM = y$, and Ordinate $MG = x$, we ſhall from the Equation $yx^{e} = 1$, find $ACMGA = \frac{\overline{e \times y}|^{\frac{e-1}{e}}}{e-1}$ but $y^{\frac{e-1}{e}} = x^{1-e}$; therefore $ACMGA = \frac{e \times x^{1-e}}{e-1}$, from which if you ſubſtract $CMGL = yx = x^{1-e}$, the Remainder will be (as Mr. *Varignon* ſays) $AGLA = \frac{x^{1-e}}{e-1}$, which is indeed the Negative of $\frac{x^{1-e}}{1-e}$. But his Concluſion is falſe and groundleſs, *viz*. that $\frac{x^{1-e}}{1-e}$ is not the Expreſſion of the Space *BGLCB*, but only (when $e \angle 1$) the negative Expreſſion of its Complement *AGLA*. For (according to the Principles of the Calculus Integralis) $\frac{x^{1-e}}{1-e}$ is as certainly the Expreſſion of the Space *BGLCB*, as its Negative $\frac{x^{1-e}}{e-1}$ is the Expreſſion of its Complement *AGLA*. And this is ſuitable to Natures Proceedings, *viz.* to do things in the ſimpleſt and moſt general Method, and conſequently to give one Expreſſion of the Area of a Figure and of its Complement, when it can be done. And may it not (with as good reaſon) be ſaid that $\frac{x^{1-e}}{e-1}$ is not the Expreſſion of the Space *A G L A* but of its Complement *B G L C B*; And not only it may be ſaid, but Mr. *Varignon* muſt ſay ſo in all the innumerable Caſes where $e \; 7 \; 1$; and to ſay it is not when $e \angle 1$, and it is when $e \; 7 \; 1$; what is this but to ſay backward and forward, according as it will anſwer his Conceit of denying that there are Spaces greater than infinite? But to put this Controverſy beyond all diſpute, let us reſolve theſe two finite Expreſſions of the Spaces *B G L C B*, and *A G L A*, into infinite Series's.

I. $\frac{x^{1-e}}{1-e} = x^{1-e} \times 1 + e + e^2 + e^3 + e^4$, &c. when you begin the Diviſion with 1, as here it naturally ſhould.

II. $\frac{x^{1-e}}{1-e} = x^{1-e} \times - \frac{1}{e} - \frac{1}{e^2} - \frac{1}{e^3} - \frac{1}{e^4}$, &c. When you begin the Diviſion with $-e$.

III. $\frac{x^{1-e}}{e-1} = x^{1-e} \times \frac{1}{e} + \frac{1}{e^2} + \frac{1}{e^3} + \frac{1}{e^4}$, &c. When you begin the Diviſion with e, as here it naturally ſhould.

IV. $\frac{x^{1-e}}{e-1} = x^{1-e} \times -1 - e - e^2 - e^3 - e^4$, &c. When you begin the Diviſion with -1.

Thus it appears that each of theſe two Expreſſions give two Series, of which the firſt is the Area directly ſought, and the other the negative Expreſſion of its Complement; ſo

$$\left\{\begin{array}{l} BGLCB = \frac{x^{1-e}}{1-e} = x^{1-e} \times 1 + e + e^2 + e^3 + e^4 + \&c. \\ -AGLA = \frac{x^{1-e}}{1-e} = x^{1-e} \times - \frac{1}{e} - \frac{1}{e^2} - \frac{1}{e^3} - \frac{1}{e^4} - \&c. \end{array}\right.$$

$$AGLA = \frac{x^{1-e}}{e-1} = x^{1-e} \times \frac{1}{e} + \frac{1}{e^2} + \frac{1}{e^3} + \frac{1}{e^4} + \&c.$$

$$-BCLCB = \frac{x^{1-e}}{e-1} = x^{1-e} \times -1 - e - e^2 - e^3 - e^4 - \&c.$$

Theſe are plain and obvious Concluſions deduced from the known and common Operations of Arithmetick, and utterly overthrow all that Mr. *Varignon* alledges againſt Spaces greater than infinite.

For without any Limitation (except $e \angle 1$) he ſays that $\frac{x^{1-e}}{1-e}$ is not the Expreſſion of *BGLCB*, but the Negative of the Space *AGLA*. And if ſo, then (by Series I.) it will follow that $x^{1-e} \times 1 + e + e^2 + e^3 + e^4$, &c. is the Negative Expreſſion of the Space *AGLA*; and this I ſay implies two manifeſt Abſurdities; (1ſt) That a Sum of affirmative Quantities is Negative, and (2dly) That the Sum of an infinite Geometrical Progreſſion, whoſe Terms are continually increaſing, is equal to a finite Quantity, *i.e.* That Affirmative is Negative, and Infinite is Finite.

That which ſeems to ſhock Mr. *Varignon* is that there ſhould be Spaces greater than infinite, for he tells us expreſly that he looks upon this as a Contradiction. But this difficulty will ſoon evaniſh, if he conſiders what is the ſimple Idea of Infinite; and becauſe he confeſſes that in the *Apollonian* Hyperbola *BGA*, the Space *BGLCB* is infinite, therefore let us take the Arithmetick value of *BGLCB* for infinite, but in that Hyperbola $e = 1$, and therefore (if we put likewiſe $x = 1$) we ſhall by Series 1 have $BGLCB = 1 + 1 + 1 + 1 + 1$ *&c.* that is $BGLCB = \infty \times 1$ or an infinite number of Units. So that when we ſay $2 + 2 + 2 + 2$ *&c.* or $\infty \times 2$ is more than infinite, no more is meant, but that it is greater then ſimple infinite or $\infty \times 1$; *i.e.* (taking $\infty \times 1$ for the Unit, by which we meaſure Quantities that are infinite) $\infty \times 2 \angle \infty \times 1$, or $2 \angle 1$.

This will be yet plainer in the Caſe of finites. It is certain no Quantity can be leſs than finite (as none can be greater than infinite) which we ſhall denote by $\odot \times 1$ or 1; when I ſay then that $\odot \times \frac{1}{2}$ is leſs then $\odot \times 1$, I mean no more but that $\frac{1}{2} \angle 1$; and becauſe I have defined the Idea of finite by $\odot \times 1$ or 1, I may very properly ſay that $\odot \times \frac{1}{2}$ or $\frac{1}{2}$ is leſs then a finite Quantity.

September 23. 1713.

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